ERDC/CRREL LR-06-7

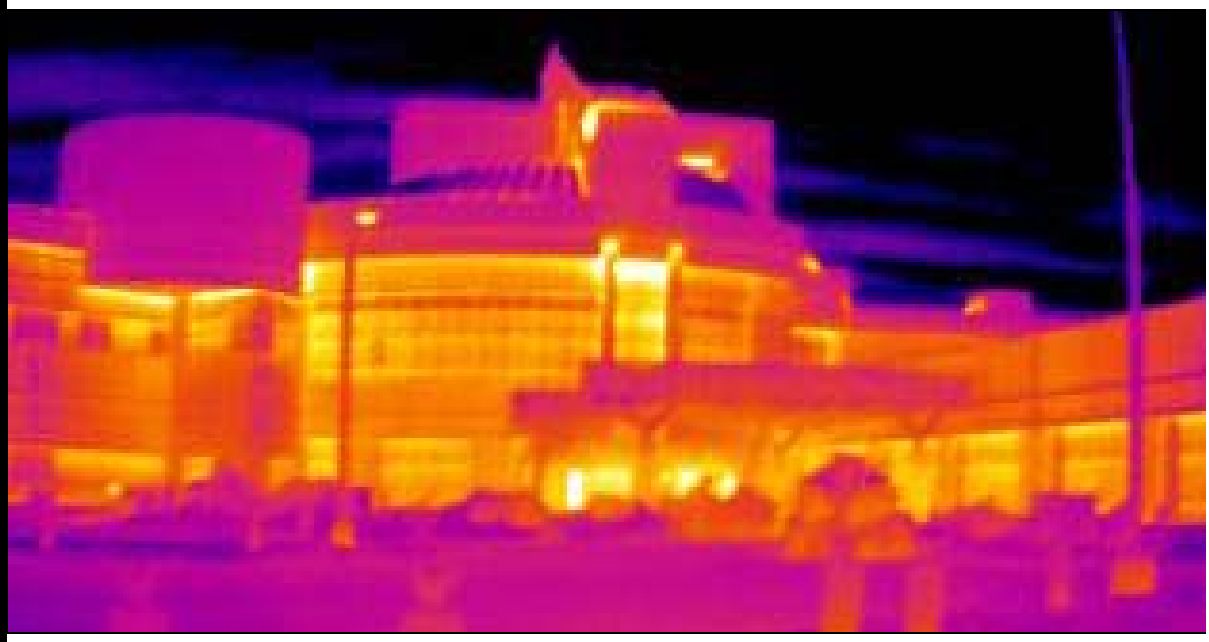
Cold Regions Research and Engineering Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

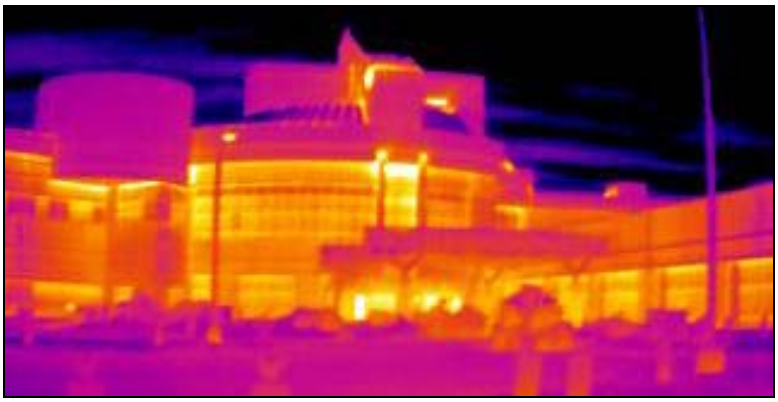
An Infrared Survey of the New Bassett Hospital, Fort Wainwright, Alaska

James Buska and Kerry Claffey

June 2006



Approved for public release; distribution is unlimited.



An Infrared Survey of the New Bassett Hospital, Fort Wainwright, Alaska

James Buska and Kerry Claffey

June 2006

Engineer Research and Development Center
Cold Regions Research and Engineering Laboratory
72 Lyme Road, Hanover, NH 03755-1290

Table of Contents

Executive Summary vii
Introduction 1
Temperature and Relative Humidity Observations 1
Infrared Surveys 2
Ground-Level Exterior Imagery 2
Roof-Level Exterior Imagery 5
Exterior Imagery from First-Floor Roof Level 5
Exterior Imagery from Second-Floor Roof Level 6
Exterior Imagery from Higher Roof Levels 7
Areas of Interest 8
Windows and Doors 8
Seismic Joints 10
West Arctic Entrance 11
Ambulance Bay Storage Rooms 11
Smoke Evacuation Fans 12
Ski Slope Walls 12
Other AOIs 12
Conclusions and Recommendations 13
Acknowledgements 16

Tables 17
Table 1. Summary statistics for temperature and relative humidity observations. 17
Table 2. Summary of infrared surveys, dates they occurred, CD directory and filenames, and number of images 18

Appendices 84
Appendix A: Attendees at 17 March 2006 Meeting 84
Appendix B: List of Areas of Interest 85
Appendix C: Attendees at 21 March 2006 Out-Brief 86
Appendix D: CD of Imagery 87

Table of Figures

Figure 1. Air temperature measured at Fairbanks International Airport. 19

Figure 2. Air temperature measured outside and in two hospital rooms. 20

Figure 3. Relative humidity measured outside and in two New Bassett Hospital rooms. 21

Figure 4. Partial vapor pressure outside and in two New Bassett Hospital rooms. 22

Figure 5. Key of ground level exterior imagery views, showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital on 18 March 2006. 23

Figure 6. View Number 1 showing visual and thermal imagery at the southwest corner of the New Bassett Hospital on 18 March 2006. 24

Figure 7. View Number 2 showing visual and thermal imagery at the southeast-facing wall near the main entrance of the New Bassett Hospital on 18 March 2006. 25

Figure 8. View Number 10A showing visual and thermal imagery at the west entrance of the New Bassett Hospital on 18 March 2006. 26

Figure 9. View Number 20 showing visual and thermal imagery at the east entrance of the New Bassett Hospital on 18 March 2006. 27

Figure 10. View Number 26 showing visual and thermal imagery at the Loading Dock entrances of the New Bassett Hospital on 18 March 2006. 28

Figure 11. View Number 32 showing visual and thermal imagery at the northeast side of the New Bassett Hospital on 18 March 2006. 29

Figure 12. View Number 41 showing visual and thermal imagery at the south ambulance garage door entrance on 18 March 2006. 30

Figure 13. View Number 44 showing visual and thermal imagery at the west side of the New Bassett Hospital near the 10-Line seismic joint on 18 March 2006. 31

Figure 14. Sample of a portion of the imagery available in the compact disk as Appendix D of this report. 32

Figure 15. Processed version of thermal image “IR_031806_073.jpg” with a temperature scale. 32

Figure 16. Key of second-floor level exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. 33

Figure 17. View Number 1-3 showing visual and thermal imagery of south-facing second-floor exterior wall of the Dental Clinic at the New Bassett Hospital on 19 March 2006. 34

Figure 18. View Number 1-4 showing visual and thermal imagery at the southeast corner of the second-floor exterior wall of the Dental Clinic on 19 March 2006. 35

Figure 19. View Number 1-10A showing visual and thermal imagery of southeast-facing portion of the central core of the New Bassett Hospital on 19 March 2006. 36

Figure 20. View Number 1-11 showing visual and thermal imagery of the horizontal seismic joint at the 19/20 Line between the VA Clinic and CEP sections of the New Bassett Hospital on 17 March 2006. 37

Figure 21. View Number 1-15 showing visual and thermal imagery of second-floor exterior walls on the northwest side of the New Bassett Hospital on 19 March 2006. 38

Figure 22. View Number 1-17 showing visual and thermal imagery of second-floor exterior walls and the roof access door at the northwest side of the New Bassett Hospital on 19 March 2006. 39

Figure 23. Key of third-floor exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. 40

Figure 24. View Number 2-2 showing visual and thermal imagery of third-floor exterior walls and seismic joints at the northeast side of the New Bassett Hospital on 19 March 2006. 41

Figure 25. View Number 2-8 showing visual and thermal imagery of third-floor exterior walls and seismic joints at the northwest side of the New Bassett Hospital on 19 March 2006. 42

Figure 26. View Number 2-9 showing visual and thermal imagery of third-floor exterior walls, ski slope, skylights, and seismic joints at the west side of the New Bassett Hospital. 43

Figure 27. View Number 2-9A showing visual and thermal imagery detail of third-floor exterior walls, seismic joints, and an exterior door. 44

Figure 28. View Number 2-12A showing visual and thermal imagery of the 10-Line seismic joint on the second-floor roof of the New Bassett Hospital. 45

Figure 29. View Number 2-13 showing visual and thermal imagery at the 10-Line seismic joint. 46

Figure 30. Key of higher-level exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. 47

Figure 31. View Number 3-1 showing visual and thermal imagery of higher exterior walls, skylights, and seismic joints at the northwest side of the New Bassett Hospital. 48

Figure 32. View Number 3-1B showing visual and thermal imagery of exterior walls and skylight at the northwest side of the New Bassett Hospital. 49

Figure 33. View Number 3-4 showing visual and thermal imagery of the skylight and ski slope at the west side of the New Bassett Hospital on 19 March 2006. 50

Figure 34. View Number 3-5 showing visual and thermal imagery of higher exterior walls at the north side of the New Bassett Hospital on 19 March 2006. 51

Figure 35. View Number 3-5A showing visual and thermal imagery of higher exterior walls and the seismic joint at the north side of the New Bassett Hospital on 19 March 2006. 52

Figure 36. Window study at the south-facing second-floor exterior wall of the Dental Clinic showing visual and thermal imagery of visual windows on 21 March 2006. 53

Figure 37. Close-up of windows in Figure 36 showing the warm header over visual windows. . 54

Figure 38. View looking west along the visual windows shown in Figure 36. 55

Figure 39. Detail showing heat loss at window header with the header location indicted by placing a warm finger on the header and removing it prior to taking thermal image.. 56

Figure 40. View from inside Room 239-20 looking out of the visual windows shown in Figure 36. 57

Figure 41. Close-up of the storefront windows shown in View Number 7. 58

Figure 42. Visual and thermal imagery of personnel door shown in View Number 39 (Fig. 5 and App. D) on 20 March 2006. Heat loss around door frame is typical of exterior doors at this hospital. 59

Figure 43. View Number 18 showing visual and thermal imagery of garage and personnel doors to the mechanical room at the east side of the New Bassett Hospital on 18 March 2006. 60

Figure 44. Visual and thermal imagery of the garage door from inside the mechanical room, shown in View Number 18 on 21 March 2006. 61

Figure 45. Visual and thermal imagery showing the seismic joint to the left of the main entrance to the New Bassett Hospital on 21 March 2006. 62

Figure 46. Close-up visual and thermal imagery showing the seismic joint to the left of the main entrance to the New Bassett Hospital on 21 March 2006. 63

Figure 47. Close-up visual and thermal imagery showing the seismic joint to the right of the main entrance to the New Bassett Hospital on 20 March 2006. 64

Figure 48. Close-up visual and thermal imagery showing the 15-Line seismic joint near View Number 6 in Figure 5 on 18 March 2006. 65

Figure 49. Location of the West Entrance at the New Bassett Hospital. 66

Figure 50. Personnel lift used to take visual and thermal imagery of the West Entrance roof..... 66

Figure 51. Unfinished flashing around the roof over the West Entrance of the New Bassett Hospital. 67

Figure 52. Thermal image of the southwest corner of the roof over the West Entrance. 67

Figure 53. Visual and thermal imagery of the roof drains inside the West Entrance of the New Bassett Hospital. 68

Figure 54. Visual and thermal imagery showing the north wall of the West Entrance in the space between the ceiling and the roof. 69

Figure 55. Location of the ambulance storage rooms at the New Bassett Hospital. 70

Figure 56. South ambulance storage room, located behind the short wall in the center of this photo. 70

Figure 57. Sprinkler system in the south ambulance storage room, located at the small end of the room surrounded by three exterior walls. 71

Figure 58. View above the ceiling tiles showing visual and thermal imagery of the short wall at the small end of the south ambulance storage room. 72

Figure 59. Drain pipe that passes through the exterior wall of the ambulance storage room..... 73
Figure 60. Drain located outside of the exterior wall of the south ambulance storage room. 73
Figure 61. Location of smoke evacuation fans at the New Bassett Hospital..... 74
Figure 62. Smoke evacuation stacks at the New Bassett Hospital on 19 March 2006. 74
Figure 63. Smoke evacuation louver on the high ceiling inside the New Bassett Hospital. 74
Figure 64. West smoke-evacuation fan showing visual and thermal imagery on 19 March 2006. 75
Figure 65. Location of the ski slope just above the fourth-floor level at the New Bassett Hospital. 76
Figure 66. Ski slope at the New Bassett Hospital on 19 March 2006. 76
Figure 67. Ski slope at the New Bassett Hospital on 19 March 2006. 77
Figure 68. View taken from the upper level inside the ski slope looking south..... 77
Figure 69. View inside the ski slope showing visual and thermal imagery on 19 March 2006. .. 78
Figure 70. View inside the ski slope showing visual and thermal imagery on 19 March 2006. .. 79
Figure 71. View inside the ski slope showing visual and thermal imagery on 19 March 2006. .. 80
Figure 72. South wall of the area above the ceiling of the conference room on 19 March 2006. 81
Figure 73. Air intake louver in Room 135-11 over the garage door shown in Figure 43..... 82
Figure 74. Exterior wall and ceiling in the north tunnel of the east water vault under the cooling tower..... 83

Executive Summary

Personnel from the Cold Regions Research and Engineering Laboratory (CRREL) conducted an inspection and infrared (IR) survey of the new Bassett Hospital at Fort Wainwright, Alaska for the U.S. Army Corps of Engineers, Alaska District in March 2006. The purpose of the inspection and IR survey was to assess and determine if there were any building envelope problems that could be identified and resolved before the construction contract was completed.

Inside and outside temperatures conditions at the New Bassett Hospital during the survey provided adequate temperature differences for the infrared camera to document heat loss across the building envelope. Exterior ground-level and roof-level infrared surveys were done early in the morning to avoid solar heat gains on the building surfaces and to take advantage of a larger temperature differential across the building envelope.

Construction of the New Bassett Hospital was still a work in progress during the infrared survey. Overall the survey results were quite good, with only a few heat loss problems related to construction still in progress, such as unfinished construction joints, unfinished seismic joints, unfinished flashing on the roof of the west entrance, and unfinished exterior surfaces. Those problems are expected to be resolved when construction is completed on the hospital.

The exterior insulation and finish system (EFIS) walls look good and are performing slightly better that the exposed concrete block walls. There is some increased heat loss around the foundation of the facility between the base of the building and its footings. However, that heat loss is not expected to be much of a problem.

Glazing systems are typical locations of increased heat loss in a building's thermal envelope. Completed glazing systems at the hospital look good, with the exception of a narrow band of increased heat loss at their headers. A review of the drawings showed wood blocking used at the header to secure the window frames and window treatments, with little or no insulation outboard of that blocking. The IR survey found these headers to be slightly cooler than the windowsill inside the facility. However, this survey does not allow a prediction of how well these glazing systems will perform during extreme cold when inside temperatures and relative humidity levels are at their stated operating levels. It may not be feasible or necessary to add insulation at these header locations.

Doors are also typical locations of increased heat loss in a building's thermal envelope. Heat losses were clearly evident around the frames of personnel doors throughout the hospital. Some of that heat loss could be due to air leakage or excessively warm interiors. Air leakage at door frames can be minimized by using good seals and by making sure that those seals remain good after they are installed. Roll-up garage doors throughout the hospital are not insulated and are major sources of heat loss in the facility. Insulated garage doors are available but are generally segmented, which may not be desirable for this facility.

Seismic joints were quite visible and generally warmer than their surrounding walls in the thermal imagery. Most vertical seismic joints were significantly warmer at the top of the joint,

indicating the occurrence of a stack effect within the vertical joint. These seismic joints are still being worked on and will be opened up and filled with batt insulation. Vertical seismic joints with the batt insulation installed did not show a stack effect in their thermal image. The use of batt insulation in the seismic joints clearly reduces the stack effect in the vertical seismic joints.

During the infrared survey no problems were found at parapets, service bay walls, building corners, or the east arctic entry.

However, some minor problems were identified in the report and are listed below so they can be resolved before the construction contract is completed.

- Bright lines in the thermal imagery of Figure 7 where the walls meet the base of the circular portion of the building indicate a potential heat loss problem there that should be further investigated.

- The bright spot in Figure 32 showing the sloped skylight at the southwest side of the hospital is truly a hot spot. There may be a flaw in the installation of the sloped glazing at this location that should be investigated.

- The cold draft in the west entrance is most likely due to the unfinished flashing on its roof. This entrance is expected to be much warmer once its roof flashing is completed. However, some insulation should be added to the cold spots around the roof drains.

- The south ambulance bay storage room with the fire sprinkler system needs some attention to avoid potential freeze damage to the sprinkler system. Some of the recommended changes below apply to both ambulance storage rooms. These storage rooms will be warmer if the following changes are implemented: reconfigure the heat distribution ductwork so heat is supplied at the small (narrow) end of the room and returns are located near the doors, install door hardware so doors are kept closed, seal air leaks around the drain pipe in the south storage room, consider using a redundant heat source near fire sprinkler system to ensure that it is kept warm enough to avoid freeze damage.

- There is a potential for considerable condensation and dripping from four large smoke evacuation fans on the roof of the hospital. Warm humid air inside the hospital was condensing on the cold surfaces of these smoke evacuation systems and dripping on the floor below. There is also a considerable amount of heat loss from these smoke evacuation fans. They should be insulated to reduce heat loss and condensation on their cold interior surfaces. Catch pans could be used to collect moisture under their louvers, or perhaps large planters placed on the floor below could accommodate any moisture dripping from the louvers.

- The ski slope is a signature feature of the New Bassett Hospital, and it also functions as an air intake plenum. However, the ski slope was not functioning as an air intake plenum during the IR survey, as evidenced its warm air intake louvers. There is a fair amount of heat loss from the warm building below into the ski slope through its floor and walls in

common with the building below. Heat losses through the walls in common with the building below and the ski slope floor could be reduced by better insulating the warm inside surfaces of those walls and floors. The north steel stud wall should be better insulated and a vapor barrier installed on the warm side of that insulation. The thermal continuity of the building envelope and continuity of the vapor barrier may have been compromised somewhat in and around the ski slope.

- There may be a potential problem with the air intake louver and sprinkler system over the mechanical room garage door. That louver opens whenever the emergency generators, boilers, or chillers are operating, and the nearby fire sprinkler system may be too close to the open louver when it's operated during periods of extreme cold. It seems reasonable to move the sprinkler system farther away from the louver if possible.

- Our personnel were asked about insulating the exterior walls and ceiling of the tunnels and water vaults under the cooling tower. However, they have no experience in this area and do not know enough about the situation to properly answer this question. Recommend finding others who may have experience operating similar cooling towers in cold regions and ask them for their advice and assistance. If nobody has such experience, consider the discussion on the matter in that section of the report.

CRREL personnel now have a much better idea of how to conduct an infrared survey of such a large facility. It's critical to have a set of basic graphics for documenting photo points as imagery is collected. The CRREL approach of obtaining the thermal imagery, printing a catalog of that imagery, and using it to obtain visual imagery from the same viewpoint worked fairly well. Either way, graphics must be made showing where the imagery was taken. It was not practical to include all of the imagery collected in this report. Instead, selected imagery was used to present and discuss the survey method and results. A compact disk (CD) of imagery provides an organized presentation of the main survey topics discussed in this report. The CD also contains all of imagery obtained during the IR survey and processed versions of the selected imagery used throughout the report and in the CD presentation.

Introduction

The U.S. Army Corps of Engineers, Alaska District asked the Cold Regions Research and Engineering Laboratory (CRREL) to conduct an inspection and infrared (IR) survey of the new Bassett Hospital at Fort Wainwright, Alaska. The purpose of the inspection and IR survey was to assess and determine if there were any building envelope problems that could be identified and resolved before the construction contract was completed.

James Buska and Kerry Claffey of CRREL met with District personnel and several others representing the contractor, architect-engineer, and customer on Friday, 17 March 2006. A list of attendees at that meeting is attached as Appendix A. During our initial meeting we discussed their expectations, areas of interest (App. B), and coordinated support for our survey.

Our inspection and infrared survey of the new Bassett Hospital still under construction at Fort Wainwright, Alaska, was conducted on 17-21 March 2006. We normally take a visual image at each location where an IR image is taken. The visual images are used to help interpret what we see in the IR image. However, almost all of the infrared imagery was obtained at night in order to limit the effects of solar warming on the exterior surfaces of the building, so the visual imagery had to be obtained later in the day by reoccupying our photo points and comparing the visual scene to color copies of the IR imagery obtained earlier that day. Consequently, visual and IR images do not always show the same field of view. A total of 1027 visual and IR images were obtained, about 45% of those being IR images. All major exterior wall surfaces of the hospital were surveyed including various wall types, windows, doors, and horizontal seismic joints not covered by snow. Roof surfaces were not surveyed since they were covered with snow and the IR camera can't see through it. A out-brief of our initial findings was presented to District personnel and several others on 21 March 2006 (App. C). A progress briefing on the format of this report and its associated CD of imagery was presented to District personnel and others on 11 April 2006. IR survey methods and results for each area of the building are described in detail in the following sections.

Temperature and Relative Humidity Observations

Figure 1 shows air temperature measured at the Fairbanks International Airport 10 days prior to our visit, during our visit, and two days after we left. A cold spell started on 9 March and ended 18 March, just as we finished our infrared survey of the ground level portions of the hospital. We installed three dataloggers to record temperature and relative humidity (RH) at 1-minute intervals in Room 110-18 on the first floor, Room 210-14 on the second floor, and outside the hospital in a sheltered area by the emergency entrance. Air temperature at those locations is shown in Figure 2, and relative humidity is shown in Figure 3. Partial vapor pressure for those locations was calculated using the measured temperature and RH values and is shown in Figure 4. Table 1 provides summary statistics for our temperature and relative humidity observations.

The outside air temperature measured by our datalogger averaged 10ºF during our visit, with a high of 22ºF and a low of –12ºF (Fig. 2). Most of our exterior infrared imagery was obtained at night during the time periods indicated in Figure 2. Air temperatures in Rooms 110-18 and 210-

14 averaged about 73ºF and ranged from 68 to 77ºF, with the first-floor room being slightly warmer (Fig. 2).

Room 210-14 on the second floor just outside the humidified surgery rooms had higher relative humidity and moisture levels than Room 110-18 on the first floor, as shown in Figures 3 and 4. Humidity was not being controlled at design levels in these areas prior to our visit since the hospital was still under construction. Apparently RH levels when controlled were only being set at relatively low values of about 20% RH. The surgery rooms were supposed to be operating at 50% RH during our visit. However, we only measured an average value of 29% RH, with a maximum value of only 34% RH in Room 210-14 just outside those surgery rooms (Fig. 3). Interior moisture levels appeared to be tracking changes in outside moisture levels, as shown in Figure 4.

Infrared Surveys

We were given a quick tour of the New Bassett Hospital and some of the areas to be surveyed on Friday, 17 March 2006 by Jerry Holland of the Alaska District, our principal contact at the hospital construction site. We obtained some miscellaneous infrared and visual imagery during that tour, which is included electronically in Appendix D.

The IR survey methods and results for each area of the building are described in detail in the following sections. Table 2 summarizes the infrared surveys and the dates they occurred, and it provides an index to the images that are included electronically in Appendix D.

The IR camera we used for the survey is an FLIR Systems S-60 ThermaCAM. The images are presented in a color scale; lighter means hotter. In the unprocessed images included in Appendix D, white is at the higher limit of range and black is at the lower. The range automatically adjusts for each image, so light yellow in one image may not represent the same temperature in another image, and the same is true for the opposite end of the temperature scale. Each of the images included in this report has been extracted from our analysis software, and thus they have a temperature scale on the right side specific to that image. Our analysis software allows us to obtain the temperature of any point in any image after the fact, within the limits of making absolute temperature measurements with IR.

Ground-Level Exterior Imagery

Our survey work began in earnest at 0310 hours on Saturday, 18 March 2006, when Kerry, Jerry, and I were joined by Ken Hoganson of Dick Pacific/GHEMM, JV representing the contractor. We started at the southwest corner of the building and walked counterclockwise around the hospital, taking overlapping infrared imagery of the exterior surfaces from ground level (Figure 5). The outside air temperature during our survey ranged from –10 to –8ºF, and there was a light to medium wind. It was quite cold! We took 122 IR images by 0632 hours, well before the sun rose. Some images were duplicates to ensure proper focus of the IR image. We've selected a few images below that best illustrate some of the areas of interest. However, we have many other

images, and they have been included in Appendix D, but those presented below best represent the types of heat losses we observed. Visual imagery was obtained after breakfast later in the day.

Note that in each IR image that follows there is a temperature scale to the right of the actual image. This temperature scale provides a key for interpreting the color-scale rendition of the apparent temperatures in that image. Darker colors are colder and lighter colors are warmer. The numerical limits shown at the top and bottom of the temperature scale are the approximate minimum and maximum temperatures within the image. Note that for optimum resolution the IR camera was used in an "auto-ranging" mode where the temperature scale is adjusted for each image to achieve the highest resolution. Thus, the temperature scale is not consistent from one image to the next and hence the interpretation of a given color is not normally consistent from one image to another.

Figure 6 shows View Number 1 of the visual and infrared imagery taken at the southwest corner of the New Bassett Hospital on 18 March 2006. This imagery is typical of most of the thermal infrared (IR) imagery taken that evening. The brightest spots in this IR image are due to exterior lights, as shown in the visual imagery. The exterior insulation and finish system (EIFS) walls are performing slightly better than the exposed concrete block walls (since the EFIS walls are slightly darker). If the wall color in the IR imagery is darker, it's colder and therefore is experiencing less heat loss. Conversely, the visual windows are brighter in the IR imagery than the spandrel glass. Consequently, the visual windows are experiencing more heat loss than the better-insulated spandrel glass portions of the exterior wall. All glass areas (visual and spandrel) had bright lines in the thermal imagery at the top of each glass area, indicating more heat loss at their headers. Window headers are discussed in more detail later this report. The bullnose detail on the exterior wall exposes more surface area to the cold ambient air and shows up as a slightly colder surface in the thermal imagery. There was snow on the ground, but whenever we could see the building's footings, we noticed a brighter line there in the thermal imagery, indicating more heat loss at the footings than from the block wall above.

Figure 7 shows View Number 2 of the visual and infrared imagery taken at the southeast-facing wall near the main entrance of the New Bassett Hospital on 18 March 2006. Like Figure 6, it shows similar information for EIFS and concrete block walls, spandrel glass and visual windows, the bullnose detail, and building footings. However, it also shows bright lines at a couple of vertical construction joints and where the walls meet the base of the circular portion of the building. During our survey that evening we saw several bright vertical construction joints. They were all experiencing more heat loss, which was evident later that day when we obtained the visual imagery. Those construction joints were not completed yet since the project was still a work in progress. We could see exposed backer rod in the unsealed construction joints and occasionally a piece of backer rod hanging out of the construction joint. We expect that those construction joints will perform better when they are completed later this summer. However, the bright lines in the thermal imagery of Figure 7 where the walls meet the base of the circular portion of the building indicate a potential heat loss problem there that should be further investigated. We were not able to obtain access to that area. The increased heat loss there may be due to an unsealed construction joint or a thermal bridge at the wall and floor intersection. The

other bright spot in the thermal imagery appears to be due to the generator shown in the visual image (Fig. 7).

Figure 8 shows View Number 10A of the visual and infrared imagery taken at the west entrance of the New Bassett Hospital on 18 March 2006. The west entrance vestibule was reported to be quite cold, but we could see no obvious problem in this exterior view other than the plywood construction door. We were able to further investigate the problems at the west entrance, which is discussed later in this report. Some additional heat loss is also evident at the headers of the store front visual and spandrel glass in this figure. There is a vertical seismic joint just to the right of the storefront windows in Figure 8. This seismic joint was performing well and showed no evidence of increased heat loss due to a stack effect within the vertical joint. However, the concrete block column between the storefront spandrel glass and the seismic joint is brighter than the adjacent concrete block wall, indicating that the column insulation is less effective than the adjacent wall insulation.

Figure 9 shows View Number 20 of the visual and infrared imagery taken at the east entrance of the New Bassett Hospital on 18 March 2006. The warm lights and heated sidewalk are quite bright in the thermal imagery. Heat loss around the building foundation is also indicated in addition to a very bright door frame. Heat loss at personnel doors around the building was much more noticeable than that occurring at walls or windows. Door frames and air leakage around personnel doors usually result in more heat loss at those locations.

Figure 10 shows View Number 26 of the visual and infrared imagery taken at the Loading Dock entrances of the New Bassett Hospital on 18 March 2006. These garage doors are major heat loss locations for the facility. The inner garage doors were open to the warmer building beyond, contributing more heat than normal to the docking areas behind these garage doors.

Figure 11 shows View Number 32 of the visual and infrared imagery taken at the northeast side of the New Bassett Hospital on 18 March 2006. As mentioned earlier, this facility was a work in progress at the time of our survey. The bright area on the center Green near the third-floor windows is a plywood cover for debris removal. The door below is also covered with plywood, and several areas of EIFS are incomplete, as shown in the visual imagery. The contractor reported that several windows on the first and second floors at the right side of the visual image were also a work in progress and were not complete at the time of our survey. Whenever we followed up and inspected those brighter windows, we generally found some work in progress. The seismic joint between the center Green and the three-story wing is one of those areas where the EIFS was incomplete.

Figure 12 shows View Number 41 of the visual and infrared imagery taken at the south ambulance garage door entrance of the New Bassett Hospital on 18 March 2006. The heated floor slab nearly overwhelms the thermal imagery as the brightest area in the image. However, these garage doors are also considerable heat loss locations for the ambulance garage. The pinkish walls around the garage door and under the emergency entrance canopy to the right are the result of those walls being warmed by the heated floor slabs below.

Figure 13 shows View Number 44 of the visual and infrared imagery at the west side of the New Bassett Hospital near the 10-Line seismic joint on 18 March 2006. The vertical seismic joint is experiencing some stack effect, resulting in a brighter or warmer upper portion of the joint, as shown in the IR image. We will discuss seismic joints in more detail later in this report. There are a couple of bright spots high on the service bay louvers, indicating some stack effect and/or heat loss there. Otherwise the service bay walls here and elsewhere look good and seem to be performing well.

All 48 views in Figure 5 showing view direction for the visual and thermal imagery taken at ground level are included in the compact disk as Appendix D. Figure 14 shows a sample of a portion of the imagery available in that CD. The imagery is hyperlinked so you can examine each image in more detail without having to sort through all the images. Clicking on the thermal image or the text "Image with Scale" will take you to a processed version of the IR imagery with a temperature scale as shown in Figure 15 below and in Figures 6 through 13 of this report.

Roof-Level Exterior Imagery

Our roof-level survey work began at 0347 hours on Sunday, 19 March 2006, when Kerry and I met with Phil Horton of the Alaska District, our guide for the roof-level surveys. We started on the first-floor roof and proceeded as shown in Figure 16, taking overlapping infrared imagery of the second-floor exterior surfaces of the hospital. We also surveyed the building from several higher roof levels, as will be discussed later in this section. We labeled our views by the roof level we were standing on when the imagery was obtained. Consequently, imagery taken from the first-floor roof level will show second-floor exterior views of the facility and so on. We took 121 IR images by 0806 hours. The outside air temperature during our survey was about 10ºF, as shown in Figure 2. It was cloudy that morning, so we obtained some visual images concurrent with the IR imagery after sunrise. The rest our visual imagery was obtained later that day. We had to contend with about 12 to 16 inches of snow and ice on the roofs, which limited ready access and precluded venturing too close to low parapets. Again, some IR images were duplicates to ensure proper focus of the image. We've selected a few images below that best illustrate some of the areas of interest. However, we have many other images, and they are included in Appendix D.

Exterior Imagery from First-Floor Roof Level

Figures 17 and 18 are Views Number 1-3 and 1-4, respectively, of the visual and infrared imagery of the south-facing second-floor exterior wall of the Dental Clinic at the New Bassett Hospital. The EIFS portion of the walls is performing better than the exposed concrete block walls below. The visual windows are experiencing more heat loss than the better-insulated spandrel glass portions of the exterior wall. As mentioned earlier, all glass areas (visual and spandrel) had bright lines in the thermal imagery at the top of each glass area, indicating more heat loss at their headers. Several unfinished construction joints were visible as bright vertical lines in the IR imagery at the time of our survey, as shown in Figures 17 and 18. Those construction joints were not completed yet since the project was still a work in progress. The

bullnose detail on the exterior wall exposes more surface area to the cold ambient air and shows up as a slightly colder surface in the thermal imagery. A small piece of horizontal bullnose trim is missing in the spandrel glass at the end of the building in Figure 18; it shows up as a truncated dark line in the IR image. Our reflections also show in the thermal image.

Figure 19 shows View Number 1-10A of the visual and infrared imagery of the southeast-facing portion of the central core of the New Bassett Hospital on 19 March 2006. There are many areas still under construction, as shown in the visual image. They show up as hot spots in the thermal image and can affect nearby surface temperature due to air leakage from the area under construction. Note that the air intake in the ski slope is warmer than 25ºF, which indicates that it is exhausting warm air instead of acting as a cold air intake.

Figure 20 shows View Number 1-11 of the visual and infrared imagery of the horizontal seismic joint at the 19/20 Line between the VA Clinic and the CEP sections of the hospital on 17 March 2006. The day before our roof survey, we determined that most of this seismic joint was covered by snow. Since the thermal camera cannot see through snow, we took this image of the only area where it was clear of snow due to a large exhaust louver located above it on the wall. That warm air melted the snow and warmed the walls below the louver.

Figure 21 shows View Number 1-15 of the visual and infrared imagery of second-floor exterior walls on the northwest side of the New Bassett Hospital on 19 March 2006. The thermal imagery is typical of that discussed previously, with several construction joints visible and a couple of warm vertical corner joints. We were not able to verify if these joints were finished or still under construction. The bright spots higher in the thermal image are due to exhaust louvers and unfinished portions of EIFS walls.

Figure 22 shows View Number 1-17 of the visual and infrared imagery of second-floor exterior walls and a roof access door at the northwest side of the New Bassett Hospital. The frame around the roof access door is quite bright and is typical of most personnel access doors we observed at the facility. They are either too leaky or have poorly insulated frames. Relative to the door, the rest of this building facade is performing quite well.

Exterior Imagery from Second-Floor Roof Level

Figure 23 is a key to the exterior imagery we obtained from the second-floor roof, showing third-floor exterior surfaces at the New Bassett Hospital on 19 March 2006. Again, we labeled our views by the roof level we were standing on when the imagery was obtained.

Figure 24 shows View Number 2-2 showing visual and infrared imagery of third-floor exterior walls, skylight, and seismic joints at the northeast side of the New Bassett Hospital. There are several other views of the seismic joint at this location in Appendix D. The vertical portion of the seismic joint is clearly warmer than the horizontal portions of the joint. A stack effect in the vertical seismic joint is stronger at this third floor wall location. The bright lines over the vertical glazing and again at the sloped intersection of the skylight with the vertical wall indicate more heat loss at those locations.

Figure 25 shows View Number 2-8 showing visual and infrared imagery of third-floor exterior walls and seismic joints at the northwest side of the New Bassett Hospital. Again, heat loss from the vertical seismic joint is quite evident. The warmest spot in Figure 24 and 25 is at the intersections of the horizontal and vertical seismic joints. A portion of the EIFS wall is clearly still under construction in Figure 25.

Figure 26 shows View Number 2-9 showing visual and infrared imagery of third-floor exterior walls, ski slope, skylights, and seismic joints at the west side of the New Bassett Hospital on 19 March 2006. The warmest spot in this thermal image is the circular air intake louver in the ski slope. It averages about 38ºF, or about 20 Fahrenheit degrees warmer than the surrounding ski slope surfaces. Clearly it was not functioning as an air intake since the air temperature at the time of our survey was about 10ºF. Most of the EIFS surfaces appear to be close to the outside air temperature.

Figure 27 shows View Number 2-9A showing visual and infrared imagery detail of third-floor exterior walls, seismic joints, and an exterior door. This view is looking southeast from the second-floor roof near the service access door. Again, the door frame is quite bright, indicating increased heat loss due to air leakage or frame conditions (the bright spots are nearly 30 Fahrenheit degrees warmer than the surrounding wall area). The wide vertical seismic joint is also fairly bright. However, its intersection with the horizontal seismic joint is again the location with the most heat loss.

Figure 28 shows View Number 2-12A showing visual and infrared imagery of the 10-Line seismic joint on the second-floor roof of the hospital. A good portion of the seismic joint was covered by snow. The metal cap flashing reflects the clear sky above, which makes interpretation of its surface temperatures difficult to interpret. The circular halo in this image is due to reflection of the surfaces in the image on the camera lens. We were not able to adequately survey seismic joints on the roofs due to snow cover and reflective cap flashings.

Figure 29 shows View Number 2-13 showing visual and infrared imagery at the top of the vertical portion of 10-Line seismic joint on the west wall. This seismic joint is also visible as a bright vertical line in Figure 13. A stack effect is strong in this seismic joint.

Exterior Imagery from Higher Roof Levels

Figure 30 is a key to the exterior imagery we obtained from roof levels higher than the second-floor roof at the New Bassett Hospital on 19 March 2006. There are several roof levels above the second-floor roof. Since it tends to be confusing, we chose to label them all as number 3 in this key.

Figures 31, 32, and 33 of View Number 3-1, 3-1B, and 3-4, respectively, show visual and infrared imagery taken from the roof level at the base of the skylight. That roof level is located between roof levels 2 and 3.

Figure 31 shows View Number 3-1 showing visual and infrared imagery of exterior walls, seismic joints, and the sloped skylight at the northwest side of the New Bassett Hospital. The vertical seismic joint and header over the vertical glazing are the brightest and therefore warmest spots in the thermal image. The warm top of the smoke evacuation fan can be seen near the top of the thermal image. Those smoke evacuation fans will be discussed later in this report.

Figure 32 shows View Number 3-1B showing visual and infrared imagery of exterior walls and the sloped skylight at the northwest side of the New Bassett Hospital. Sloped glazing is particularly difficult to interpret since is reflects nearby warm surfaces and the clear sky above. The bright spot in this image is truly a hot spot, as we viewed it from several angles and it showed up in all views. There may be a flaw in the installation of the sloped glazing at his location.

Figure 33 shows View Number 3-4 showing visual and infrared imagery of the ski slope and the sloped skylight at the southwest side of the hospital. Again, the warmest area is the circular air intake on the ski slope. Its reflection in the sloped glazing can also be seen in the thermal image. Heat loss around the frame of the access door for the roof above the sloped skylight is also noticeable.

Figure 34 shows View Number 3-5 showing visual and infrared imagery of exterior walls higher than the third-floor roof, the north side of the ski slope, and smoke evacuation fans at the north side of the hospital. This view was taken from the third-floor roof level looking south towards the central core of the hospital. The brightest areas are due to exhaust louvers on the fifth floor. The access door and smoke evacuation fans are also visible on their roof level.

Figure 35 shows View Number 3-5, which is a closer look at the north wall seismic joints in Figure 34. The top of the vertical seismic joint can be seen at the left side of the thermal image (it's fairly warm). The bright spots on the horizontal portion of the seismic joints are reflections of warm louvers behind us on the third-floor roof. The horizontal seismic joints in this facility appear to be functioning reasonably well. The warm louver above is also clearly visible.

Areas of Interest

Alaska District personnel had a list of several areas of interest during our initial meeting on 17 March 2006 (App. B). We resolved several areas of interest (AOI) while we were on site conducting our infrared surveys; there were no observable problems at parapets, service bay walls, building corners, or the east arctic entry. The remaining areas of interest will be covered in the following order: Windows and doors, seismic joints, west arctic entrance, ambulance bay storage rooms, smoke evacuation fans, ski slope walls, and other AOIs.

Windows and Doors

During our survey we noticed that all glass areas (visual and spandrel) had bright lines in the thermal imagery at the top of each glass area, indicating more heat loss at their headers (Fig. 6, 7,

15, App. D). A review of the drawings showed wooden headers for securing the window frames and window treatments with little or no insulation outboard of those headers.

We decided to take a closer look at the south-facing windows of the Dental Clinic, which were easily accessible from the first-floor roof (Fig. 17 and 36). Our infrared window study was conducted before sunrise on 21 March 2006, and our visual images were obtained later that morning. The outside air temperature during our survey was about 17ºF, as shown in Figure 2. Figures 37 and 38 are close-up views showing the warm header over the visual windows in Figure 36. To pinpoint the header location, we placed a warm finger just above the header trim and removed it prior to taking the thermal image as shown in Figure 39. Interpretation of apparent temperatures of glass surfaces are complicated by reflections of other warm surfaces in the glazing, such as our reflections in Figure 37. Taking these reflections into consideration, we see that the headers over these visual windows are clearly losing more heat than any other component of the window system. Their apparent surface temperatures are about 5 to 10 Fahrenheit degrees warmer than other portions of the window frames.

Figure 40 was taken inside the Dental Clinic looking out of the windows shown in Figure 36. Darker colors indicate colder surfaces in this thermal image. The header is partially covered by the window shades. However, it still shows up as a dark line over those shades. Most interior window and wall surfaces were quite warm at the time this imagery was collected. The heaters below the windows had also been off long enough to cool down prior to our taking the thermal image. The header is just a few degrees colder than the windowsill in this thermal image. This survey does not allow us to predict how well these windows will perform during extreme cold when inside temperatures and relative humidity levels are at their stated operating levels. Interior moisture condenses on any window or wall surface colder than the dew point of the inside air. That performance test will most likely occur sometime next winter.

We also took a closer look at the storefront windows shown Figure 41 located at View Number 7 (Fig. 5 and App. D). Higher heat losses through the header over these windows are also clearly visible as a bright line. It appears that the headers over visual, spandrel, and storefront glazing areas are one of the weak points in the hospital's thermal envelope. It may not be feasible or necessary to add insulation at these header locations. However, further study of the as-built glazing systems used in this facility may be warranted if there is enough concern about their future performance.

Heat loss was also clearly evident around the frames of personnel doors throughout the hospital, as shown in Figures 9, 22, and 27. Figure 42 shows a personnel door at View Number 39 (Fig. 5 and App. D) on 20 March 2006. Heat loss around this door frame is typical of exterior personnel doors at this hospital. Some heat loss around the doors shown in these figures could be due to air leakage or excessively warm interiors. We suspect that air leakage was part of the problem for the door shown in Figure 22 and that an excessively warm mechanical room and/or air leakage may have contributed to heat loss around the door shown in Figure 27.

Figure 43 shows an outside view and Figure 44 an inside view of the mechanical room garage door on the east side of the hospital. Figures 10 and 12 also show garage doors at other locations

around the hospital. These rollup garage doors are not insulated and are major sources of heat loss in the hospital facility.

Windows and doors are typically locations of increased heat loss in a building's thermal envelope. The main questions concern the amount of heat loss we can tolerate at these locations and whether or not interior moisture will condense on their cold surfaces. Air leakage around window and door frames can be minimized by using good seals. Insulated garage doors are available but are generally segmented, which may not be desirable for this facility.

Seismic Joints

Seismic joints were visible and generally warmer than their surrounding walls throughout the previously covered sections on ground and roof-level exterior imagery. Vertical seismic joints were generally much warmer at the top of the joint, indicating a stack effect within the seismic joint (Fig. 13 and 29). Some vertical seismic joints on third-floor exterior walls were quite bright, indicating an even stronger stack effect (Fig. 24 and 25). These vertical seismic joints are apparently still a work in progress, as it was recognized that they needed to be opened up and filled with batt insulation. The 19/20-Line seismic joint shown in Figure 8 did not have the visible stack effect temperature differential, and it was reported to already include the necessary batt insulation. The seismic joints shown in Figures 24 and 25 are even more complex, as they have both horizontal and vertical components that are circular in plan view. It's the intersections of their horizontal and vertical seismic joints that show the most heat loss in those figures.

Figure 45 shows the seismic joint to the left of the main entrance to the hospital. This is one end of a complex seismic joint that circles the central core of the hospital. This vertical seismic joint has a small horizontal section near the top followed by a short vertical section at its top. The top portion of this seismic joint is much warmer than the lower portion, indicating that a stack effect exists within the joint (Fig. 46). The back side of the top of this seismic joint is shown in Figure 27. The other end of the circular seismic joint around the central core of the hospital is shown in Figure 47. This vertical seismic joint, though not as tall as the one in Figure 45, did not appear to be warmer at the top. We believe that it was also filled with batt insulation to minimize the stack effect within the seismic joint. Figure 48 shows a vertical portion of the 15-Line seismic joint that was open and still under construction.

The use of batt insulation in the seismic joints clearly reduces the stack effect in the vertical seismic joints. We expect that its use in all seismic joints when the construction is completed will help to reduce the more pronounced heat loss visible in Figures 24 and 25. As stated earlier, we were not able to see through the snow-covered seismic joints on the roofs, and many of the horizontal seismic joints were covered with reflective metal flashings, which made an assessment of their performance difficult to interpret.

West Arctic Entrance

We were asked to investigate and survey the west arctic entrance of the hospital, since it was reported to be quite cold. However, our initial external survey did find any reason that the entrance was cold, as previously mentioned and shown in Figure 8. Figures 49 and 50 show the location of the west entrance and the personnel lift we used to obtain visual and thermal imagery of its roof. The imagery in Figures 51 and 52 clearly shows that there is unfinished flashing on the roof of the west entrance, which is most likely the primary reason that the entrance is so cold. We also used our infrared camera to investigate the inside walls and roof of the west entrance by accessing the space between its ceiling and roof. Figure 53 shows cold spots around the roof drains, and Figure 54 shows cold spots along the north wall of the west entrance. We expect that this entrance will be much warmer once its roof flashing is completed. However, some insulation should be added to cover the cold spots around the roof drains.

Ambulance Bay Storage Rooms

Figure 55 shows the location of two ambulance bay storage rooms that were reported to be quite cold during a recent cold spell. Both storage rooms have three exterior walls, as shown in Figure 56. We did not see any obvious heat losses or problems in our exterior IR survey of these exterior walls (Fig. 12) or in our more detailed exterior inspection of the ambulance bay storage room walls in Appendix D. The main concern is the fire sprinkler system located in the south storage room, as shown in Figure 57. Unfortunately the sprinkler system is located at the small end of the storage room, which is also the coldest spot in the room. Most of the heat in the storage room was collecting in the space above the ceiling tiles due to stratification of the air in these rooms. The ceiling tiles were not in place at the time of our visit. The upper portion of the short wall above the ceiling tiles at the small end of the south storage room has several cold spots, as shown in Figure 58. The north storage room had no similar cold spots on its short wall above the ceiling tiles. However, it had a much better setup for distributing heat throughout the room. The warm air duct in the north storage room was located near the narrow end of the room and the air return was located at the large end of the room near the door. The south ambulance bay storage room had the opposite heat distribution setup, with the warm air supply located at the large end of the room near the door. We recommend switching the supply and return locations in the south storage room to provide warm air flow directly over the fire sprinkler system. There was also no closure hardware on the doors to ensure that the storage room doors are closed. We also found an air leak around the drain pipe for the fire sprinkler system (Fig. 59 and 60). The drain pipe was loose in its penetration through the exterior wall and not properly sealed. The considerable amount of air leakage around it can be minimized by insulating and sealing the air space around the drain pipe. We expect that these rooms will be warmer if the following changes are implemented: reconfigure the heat distribution ductwork so that heat is supplied at the small (narrow) end of the room and returns are located near the doors, install door hardware so doors are kept closed, seal air leaks around the drain pipe in the south storage room, consider using redundant heat source near the fire sprinkler system to ensure that it is kept warm enough to avoid freeze damage.

Smoke Evacuation Fans

Four large smoke evacuation fan stacks are located on the roof of the New Basset Hospital, as shown in Figures 61 and 62. Their louvers are located high on the ceiling inside the central core area of the hospital (Fig. 63). Warm humid air inside the hospital was condensing on the cold surfaces of these smoke evacuation systems and dripping on the floor below during our visit. Figure 64 shows visual and thermal imagery of the west smoke evacuation fan. There is a considerable amount of heat loss from these smoke evacuation fans. They should be insulated to reduce heat loss and condensation on their cold interior surfaces. However, we expect that even then they will still be a source of interior moisture problems (i.e., interior moisture will still condense inside them and drip on the floor below). Catch pans could be used to collect moisture under the louvers in Figure 63, or perhaps planters could be placed on the floor below. The hospital was not operating at its specified humidity levels during our visit, so there is a potential for considerable condensation and dripping from these smoke evacuation fans during cold periods.

Ski Slope Walls

The ski slope is a signature feature of the New Bassett Hospital and is located as shown in Figure 65. This feature is shown from two different viewpoints in Figures 66 and 67. The ski slope also functions as an air intake plenum, as evidenced by the circular louvers on its sides (Fig. 68). We were asked to look for potential heat loss at the walls of the ski slope. Figure 69 shows visual and thermal imagery taken from the lower level looking up towards an air intake on the upper level inside the ski slope. The air intake louver was the warmest surface in this image. The ski slope was not functioning as an air intake plenum during our visit, as evidenced by the warm air intake louvers in Figures 19, 26, and 33. We did find a fair amount of heat loss from the warm building below into the ski slope through its floor and walls in common with the building below. Figure 70 is a view of the north wall just below the upper level inside the ski slope. This metal stud wall is common to both the ski slope outside and the area just above the conference center ceiling inside the hospital. Figure 71 shows the northwest corner in the lower level at the base of the ladder shown in Figure 69. The west wall is adjacent to the sloped glazing in Figure 62. Heat losses through these steel stud walls and the ski slope floor could be reduced by better insulating the warm inside surfaces of these walls and floors. Figure 72 shows the back side of the north wall inside the ski slope. This view is taken from inside the conference room looking up through the ceiling grid towards the south wall of the conference room (i.e., the other side of the north wall in the ski slope). The steel studs are essentially not insulated against cold conditions inside the ski slope. This wall should be better insulated and a vapor barrier installed on the warm side of that insulation. We suspect that thermal continuity of the building envelope and continuity of the vapor barrier may have been compromised somewhat in and around the ski slope (App. D).

Other AOIs

Figure 73 shows an air intake louver over the garage door shown in Figure 43. That louver opens whenever the emergency generators, boilers, or chillers are operating. Sprinkler heads and

plumbing for the fire sprinkler system are located near this louver. They may be too close to the open louver when it's opened during periods of extreme cold. If so, they may freeze and break, flooding the area below during emergency operation of the generators. We did not have time to adequately study this potential problem. However, it seems sensible to move the sprinkler heads away from the louver if possible.

Figure 74 is a view of the exterior wall and ceiling in the north tunnel of the east water vault under the cooling tower. The cooler exterior wall is shown on the left and the warmer interior wall between the water vault and the stairway is shown on the right side of this imagery. The question we were asked was whether or not the exterior walls and ceiling of the tunnels and water vaults should be insulated. Apparently they were not insulated. We have no experience in this area and do not know enough about the situation to answer the question. However, we would normally place insulation on the outside if we were going to insulate these areas. Insulating the inside surfaces of the exterior walls and ceilings could introduce freeze-thaw problems in the concrete, depending on the moisture content of the walls and ceiling. Our gut feeling would be to leave the walls uninsulated and rely on ground heat to warm them. However, it may be necessary to insulate the outside surface of the ceiling with removable insulation blankets during the winter to avoid potential freeze-up problems in the water vaults. We recommend finding others who may have experience operating similar cooling towers in cold regions and asking them for their advice and assistance. The first winter's operation may sort this out whatever you decide to do.

Conclusions and Recommendations

Inside and outside temperatures conditions at the New Bassett Hospital during our survey on 17-21 March 2006 provided adequate temperature differences for the infrared camera to document heat loss across the building envelope. However, some temperature and humidity control systems in the hospital were still being worked on and were not functioning at their specified operating levels. Exterior ground-level and roof-level infrared surveys were done early in the morning to avoid solar heat gains on the building surfaces and to take advantage of a larger temperature differential across the building envelope.

Construction of the New Bassett Hospital was still a work in progress during our infrared survey. Overall the survey results were quite good, with only a few heat loss problems related to construction still in progress, such as unfinished construction joints, unfinished seismic joints, unfinished flashing on the roof of the west entrance, and unfinished exterior surfaces (e.g., EIFS surfaces, window flashing and trim, doors and windows left out for construction purposes). We expect that these problems will be resolved when construction is completed on the hospital.

The exterior insulation and finish system (EFIS) walls look good and are performing slightly better that the exposed concrete block walls. There is some increased heat loss around the foundation of the facility between the base of the building and its footings. These areas were difficult to survey due to the ground snow cover. However, we do not believe that heat loss to be much of a problem. During our infrared survey we found no problems at parapets, service bay walls, building corners, or the east arctic entry. However, bright lines in the thermal imagery of Figure 7 where the walls meet the base of the circular portion of the building indicate a potential heat loss problem there that should be further investigated.

Glazing systems are typical locations of increased heat loss in a building's thermal envelope. Completed glazing systems (visual, spandrel, and storefront) at the hospital look good, with the exception of a narrow band of increased heat loss at their headers. A review of the drawings showed wood blocking used at the header to secure the window frames and window treatments, with little or no insulation outboard of that blocking. The IR survey found these headers to be slightly cooler than the windowsill inside the facility. However, this survey does not allow us to predict how well these glazing systems will perform during extreme cold when inside temperatures and relative humidity levels are at their stated operating levels. It may not be feasible or necessary to add insulation at these header locations. However, further study of the as-built glazing systems used in this facility may be warranted if there is enough concern about their future performance.

The bright spot in Figure 32 showing the sloped skylight at the southwest side of the hospital was truly a hot spot, as we viewed it from several angles and it showed up in all views. There may be a flaw in the installation of the sloped glazing at his location that should be investigated.

Doors are also typical locations of increased heat loss in a building's thermal envelope. Heat losses were clearly evident around the frames of personnel doors throughout the hospital. Some of that heat loss could be due to air leakage or excessively warm interiors. Air leakage at door frames can be minimized by using good seals and by making sure that those seals remain good after they are installed. Roll-up garage doors throughout the hospital are not insulated and are major sources of heat loss in the facility. Insulated garage doors are available but are generally segmented, which may not be desirable for this facility.

Seismic joints were quite visible and generally warmer than their surrounding walls in the thermal imagery. Most vertical seismic joints were significantly warmer at the top of the joint, indicating the occurrence of a stack effect within the vertical joint. These seismic joints are still being worked on and will be opened up and filled with batt insulation. Vertical seismic joints with the batt insulation installed did not show a stack effect in their thermal image. The use of batt insulation in the seismic joints clearly reduces the stack effect in the vertical seismic joints. We were not able to see through the snow-covered seismic joints on the roofs, and many of the horizontal seismic joints were covered with reflective metal flashings, which made an assessment of their performance difficult to interpret.

The cold draft in the west entrance is most likely due to the unfinished flashing on its roof. We expect that this entrance will be much warmer once its roof flashing is completed. However, some insulation should be added to the cold spots around the roof drains.

The south ambulance bay storage room with the fire sprinkler system needs some attention to avoid potential freeze damage to the sprinkler system. Some of our recommended changes below apply to both ambulance storage rooms. We expect that these storage rooms will be warmer if the following changes are implemented: reconfigure the heat distribution ductwork so heat is supplied at the small (narrow) end of the room and returns are located near the doors, install door hardware so doors are kept closed, seal air leaks around the drain pipe in the south storage room,

consider using a redundant heat source near fire sprinkler system to ensure that it is kept warm enough to avoid freeze damage.

There is a potential for considerable condensation and dripping from four large smoke evacuation fans on the roof of the hospital. Warm humid air inside the hospital was condensing on the cold surfaces of these smoke evacuation systems and dripping on the floor below during our visit. There is also a considerable amount of heat loss from these smoke evacuation fans. They should be insulated to reduce heat loss and condensation on their cold interior surfaces. Catch pans could be used to collect moisture under their louvers, or perhaps large planters placed on the floor below could accommodate any moisture dripping from the louvers.

The ski slope is a signature feature of the New Bassett Hospital, and it also functions as an air intake plenum. However, the ski slope was not functioning as an air intake plenum during our visit, as evidenced its warm air intake louvers. We did find a fair amount of heat loss from the warm building below into the ski slope through its floor and walls in common with the building below. Heat losses through the walls in common with the building below and the ski slope floor could be reduced by better insulating the warm inside surfaces of those walls and floors. The north steel stud wall should be better insulated and a vapor barrier installed on the warm side of that insulation. We suspect that thermal continuity of the building envelope and continuity of the vapor barrier may have been compromised somewhat in and around the ski slope.

We were not able to adequately study the potential problem with the air intake louver and sprinkler system over the mechanical room garage door. That louver opens whenever the emergency generators, boilers, or chillers are operating, and the nearby fire sprinkler system may be too close to the open louver when it’s operated during periods of extreme cold. However, it seems reasonable to move the sprinkler system farther away from the louver if possible.

We were asked about insulating the exterior walls and ceiling of the tunnels and water vaults under the cooling tower. However, we have no experience in this area and do not know enough about the situation to properly answer this question. We recommend that you find others who may have experience operating similar cooling towers in cold regions and ask them for their advice and assistance. If nobody has such experience, consider our thoughts on the matter in that section of the report.

We now have a much better idea of how to conduct an infrared survey of such a large facility. It’s critical to have a set of basic graphics for documenting photo points as imagery is collected. Our approach of obtaining the thermal imagery, printing a catalog of that imagery, and using it to obtain visual imagery from the same viewpoint worked fairly well. Either way, graphics must be made showing where the imagery was taken. It was not practical to include all of the imagery we collected in this report. Instead, we used selected imagery to present and discuss our survey method and results. We also prepared a compact disk (CD) of imagery, which provides an organized presentation of the main survey topics discussed in this report. The CD also contains all of imagery we obtained during our survey and processed versions of the selected imagery used throughout the report and in the CD presentation.

Acknowledgements

We appreciate the help and guidance provided by Jerry Holland and Phil Horton of the Alaska District, our guides for the ground and roof-level surveys. We would probably still be wandering the hospital looking for an exit if it weren't for their help and guidance. Dan Gerdes also showed us around and provided the base graphics we adapted for use in this report. Ken Hoganson accompanied us during the ground-level infrared survey and provided information on window status and relative humidity levels.

Tables

Table 1. Summary statistics for temperature and relative humidity observations.

		Outside	Room 110-18	Room 210-14
Temperature (ºF)	Maximum	22.3	77.3	74.8
	Average	10.2	73.4	71.9
	Minimum	–11.6	68.4	69.0
Relative Humidity (%)	Maximum	73	26	34
	Average	47	19	29
	Minimum	20	12	19
Vapor Pressure (psia)	Maximum	0.036	0.119	0.132
	Average	0.017	0.079	0.113
	Minimum	0.003	0.048	0.077

Table 2. ***Summary of infrared surveys, dates they occurred, CD directory and filenames, and number of images.***

Main Survey Topics	Directory	Date	Beginning Image	Ending Image	Infrared Images	Visual Images	Total Images
Seismic Joints Miscellaneous Imagery	mar_17	Friday, 17 Mar 06	IR_031706_005	IR_031706_057	35	18	53
Ground Level Exterior Imagery	mar_18_1	Saturday, 18 Mar 06	IR_031806_001	IR_031806_056	54	2	56
Ground Level Exterior Imagery	mar_18_2	Saturday, 18 Mar 06	DC_031806_001	IR_031806_075	68	7	75
Roof Level Exterior Imagery Ski Slope Walls Smoke Evacuation Fans	mar_19_1	Sunday, 19 Mar 06	IR_031906_001	IR_031906_093	84	9	93
Smoke Evacuation Fans	mar_19_2	Sunday, 19 Mar 06	IR_031906_001	IR_031906_037	37	0	37
West Arctic Entrance	mar_20_1	Monday, 20 Mar 06	IR_032006_001	DC_032006_094	78	16	94
Ambulance Bay Storage Rooms	mar_20_2	Monday, 20 Mar 06	IR_032006_001	IR_032006_021	11	10	21
Windows and Doors Seismic Joints	mar_20_3	Monday, 20 Mar 06	IR_032006_001	DC_032006_051	32	19	51
Windows and Doors Seismic Joints	mar_21_1	Tuesday, 21 Mar 06	DC_032106_001	DC_032106_059	40	19	59
Louver Over Mechanical Room Garage Door Water Vaults Under Cooling Tower	mar_21_2	Tuesday, 21 Mar 06	IR_032106_001	IR_032106_041	24	17	41
Ground Level Exterior Imagery Seismic Joints	2006-03-17_Friday	Friday, 17 Mar 06	DSC07991	DSC08025	0	35	35
Ground Level Exterior Imagery	2006-03-18_Saturday	Saturday, 18 Mar 06	DSC08026	DSC08071	0	46	46
Roof Level Exterior Imagery Ski Slope Walls Smoke Evacuation Fans	2006-03-19_Sunday	Sunday, 19 Mar 06	DSC08080	DSC08266	0	187	187
West Arctic Entrance Ambulance Bay Storage Rooms Seismic Joints	2006-03-20_Monday	Monday, 20 Mar 06	DSC08267	DSC08331	0	65	65
Windows and Doors Louver Over Mechanical Room Garage Door Water Vaults Under Cooling Tower	2006-03-21_Tuesday	Tuesday, 21 Mar 06	DSC08332	DSC08403	0	72	72
West Arctic Entrance	kerry_visual	17-21 Mar 06	DSCN0167	DSCN0208	0	42	42
Total Images					463	564	1027

Note: The infrared camera is capable of taking both infrared (IR) and visual (DC) imagery. The “JPG” filename extensions have been dropped for compactness.

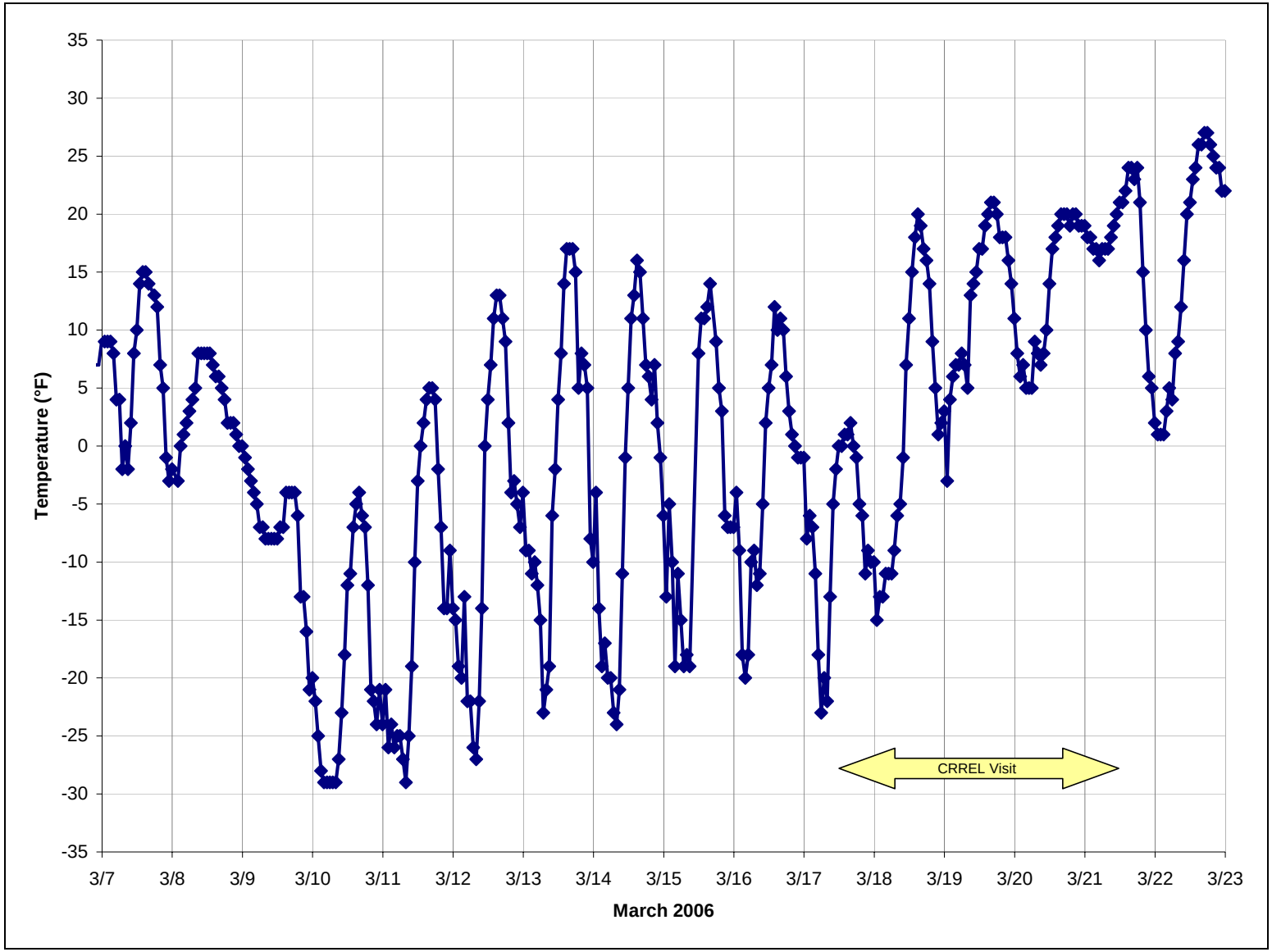


Figure 1. Air temperature measured at Fairbanks International Airport, with an arrow indicating time period of CRREL visit.

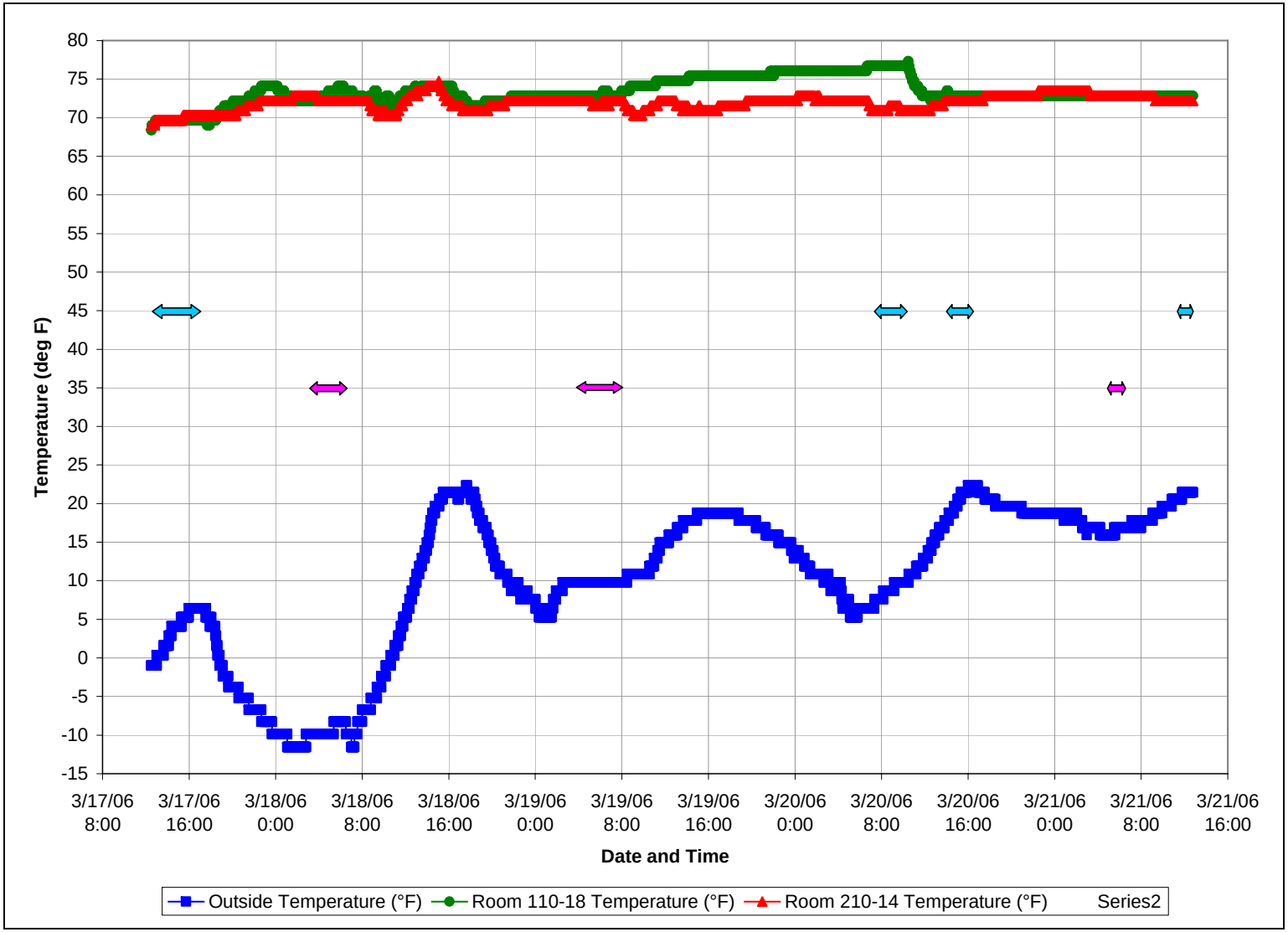


Figure 2. Air temperature measured outside and in two hospital rooms. The pink arrows indicate time periods when IR imagery was obtained at night. The light blue arrows indicate IR imagery obtained during the daytime, either inside or outside of the facility.

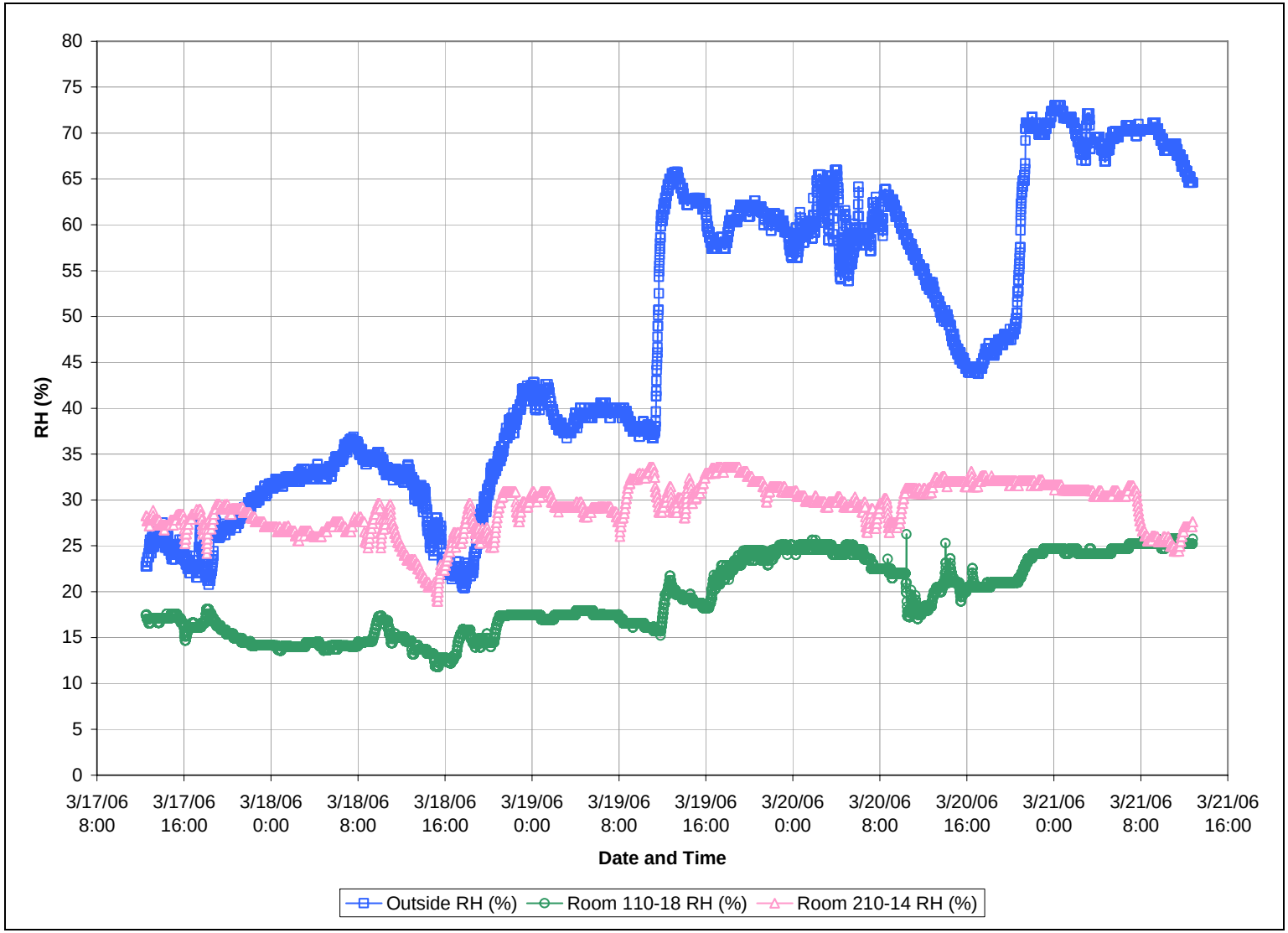


Figure 3. Relative humidity measured outside and in two New Bassett Hospital rooms.

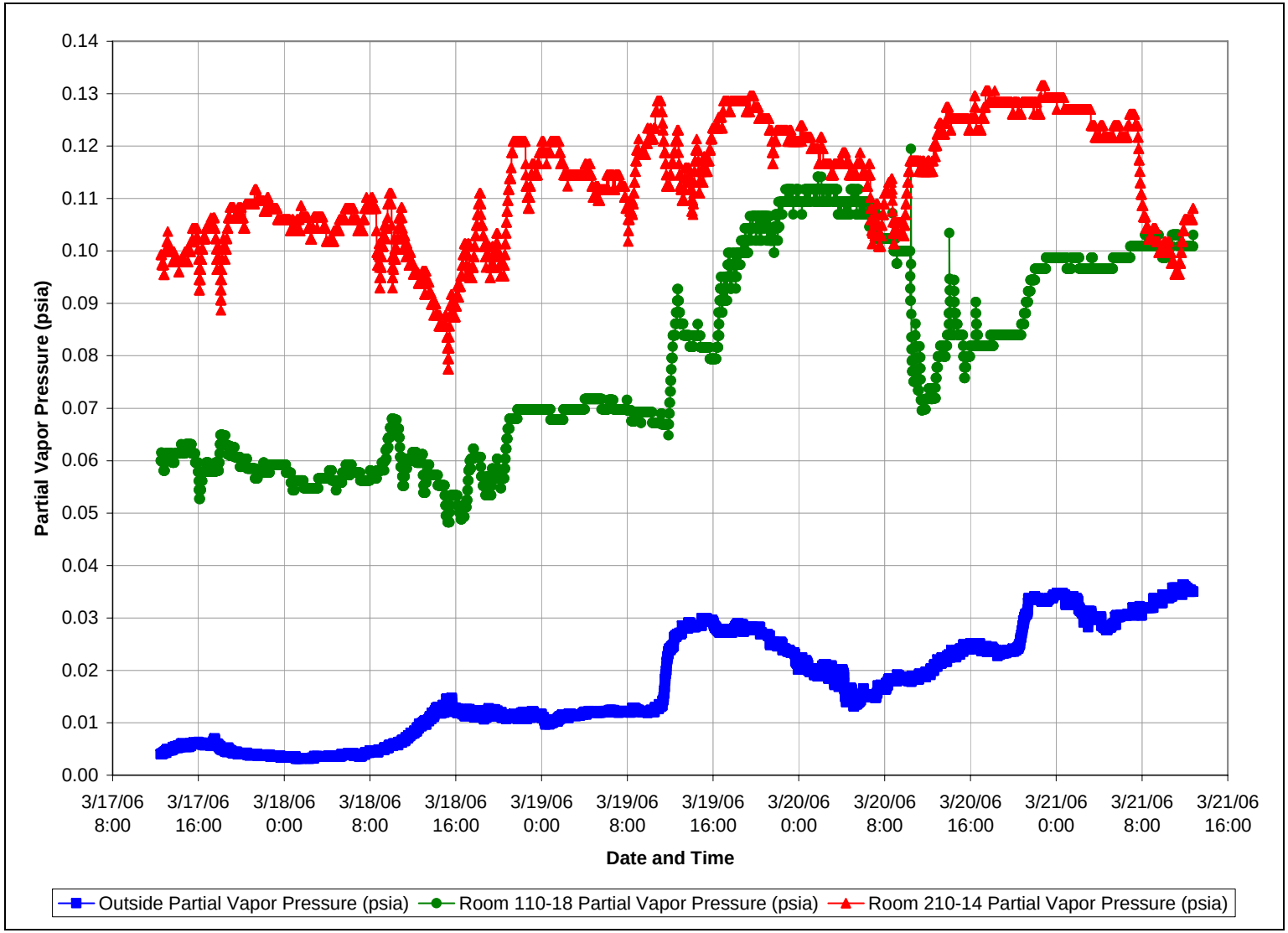


Figure 4. Partial vapor pressure outside and in two New Bassett Hospital rooms.

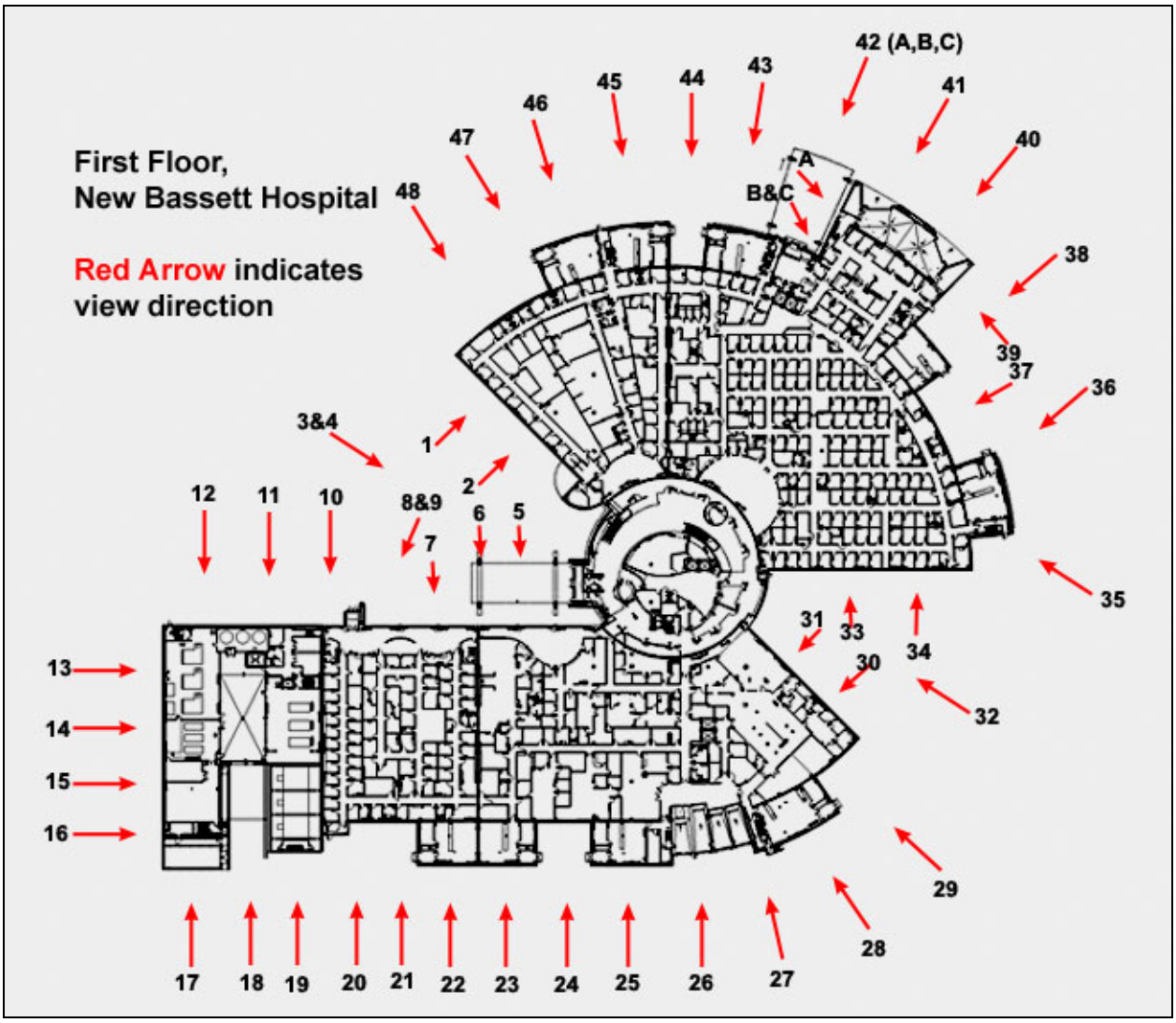


Figure 5. Key of ground level exterior imagery views, showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital on 18 March 2006. The north side of the building is at the right side of the figure.

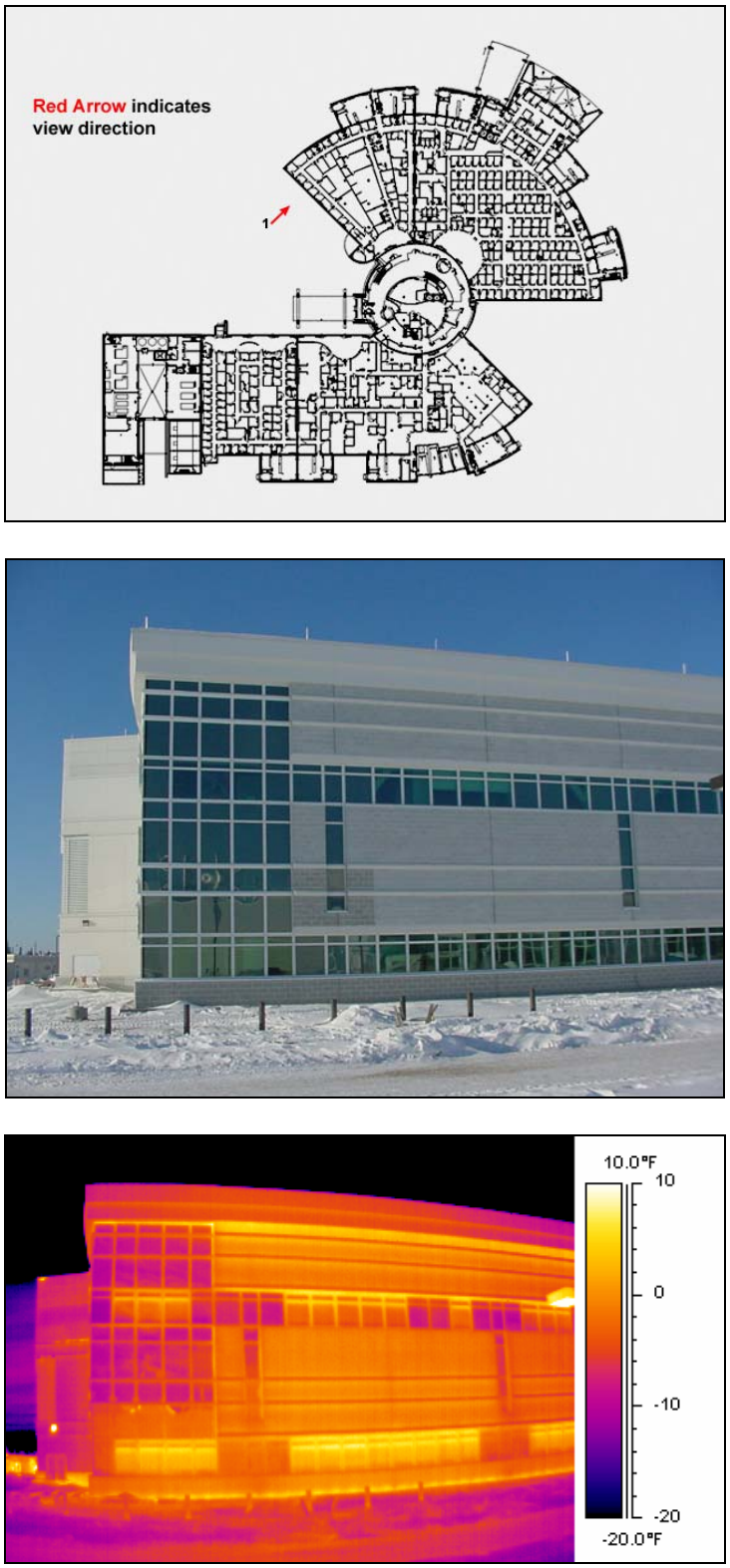


Figure 6. View Number 1 showing visual and thermal imagery at the southwest corner of the New Bassett Hospital on 18 March 2006.

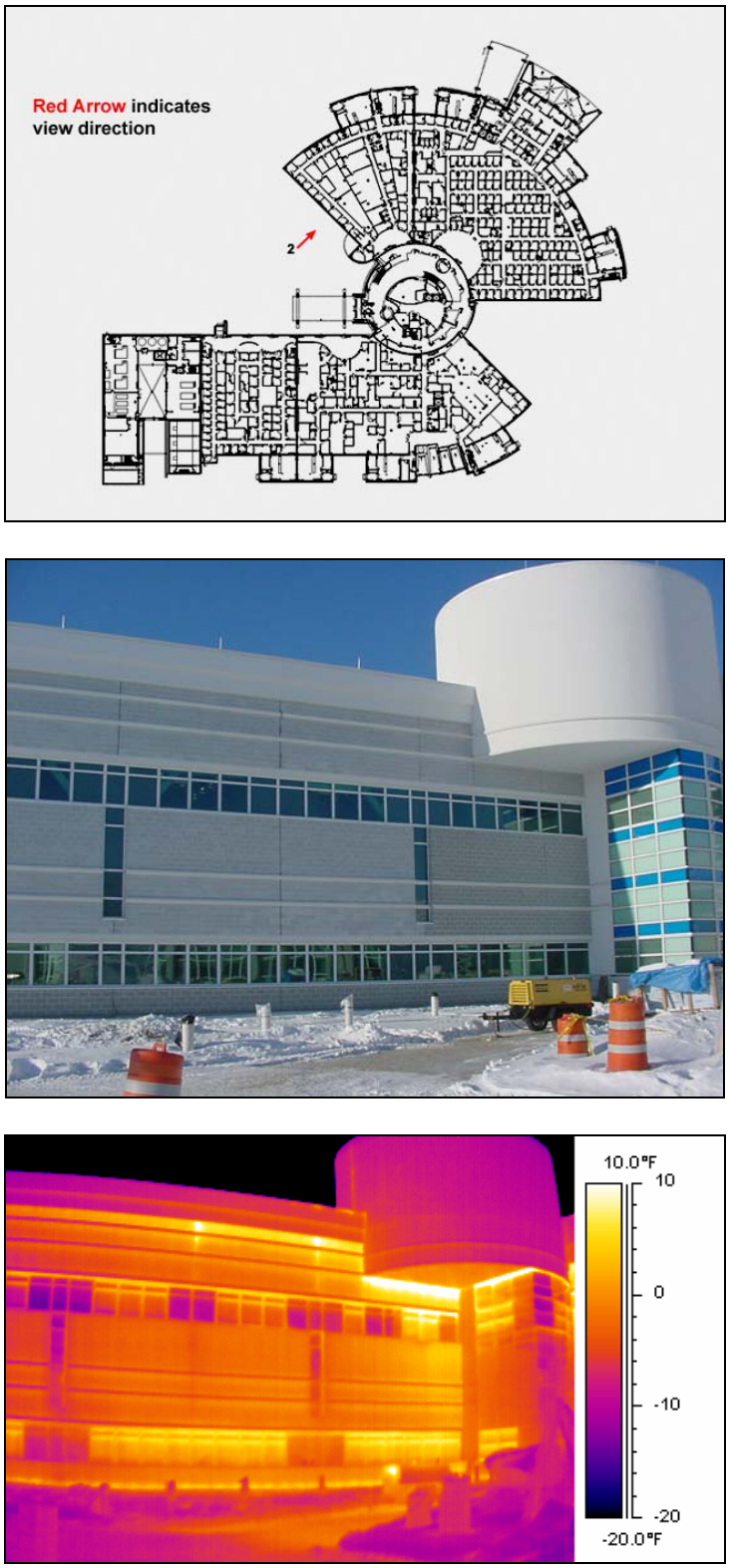


Figure 7. View Number 2 showing visual and thermal imagery at the southeast-facing wall near the main entrance of the New Bassett Hospital on 18 March 2006.

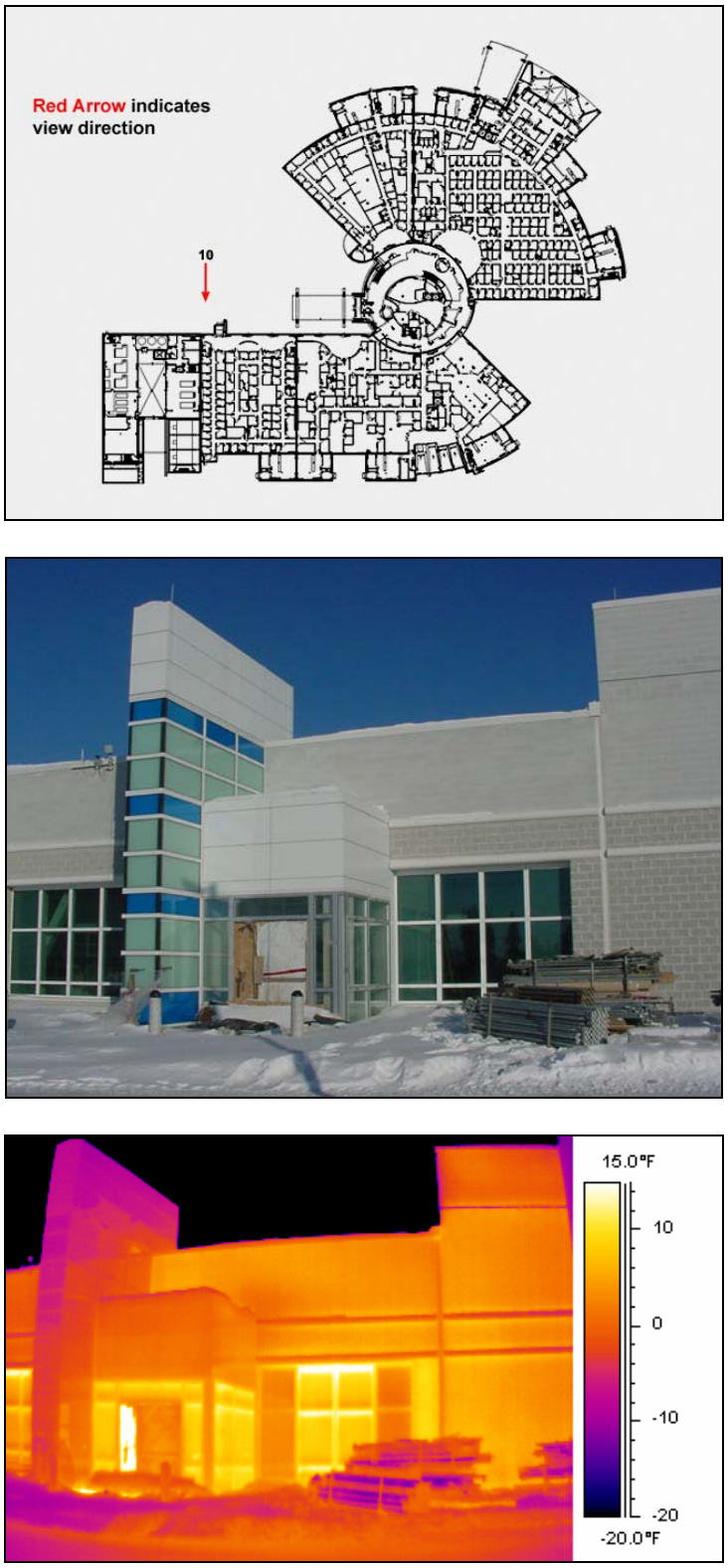
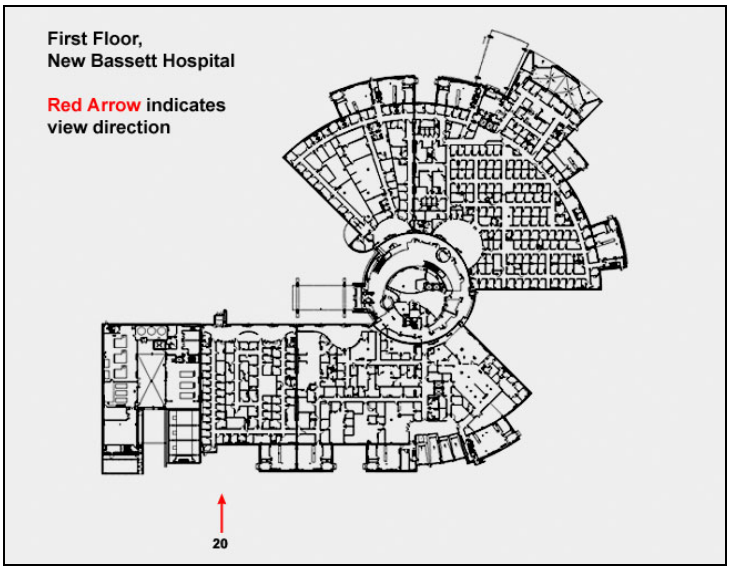


Figure 8. View Number 10A showing visual and thermal imagery at the west entrance of the New Bassett Hospital on 18 March 2006.



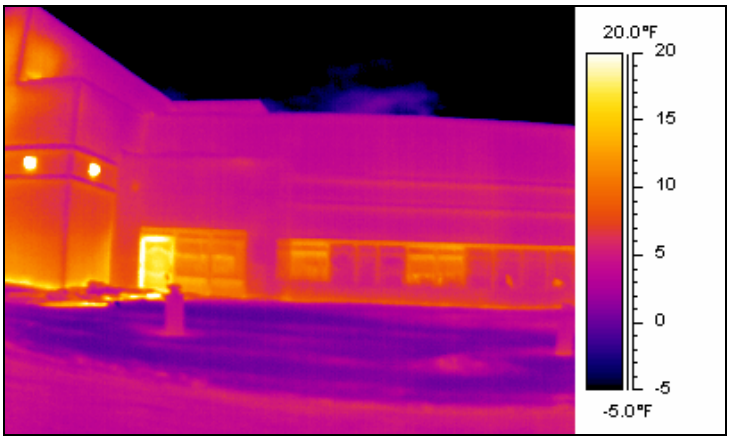


Figure 9. View Number 20 showing visual and thermal imagery at the east entrance of the New Bassett Hospital on 18 March 2006.

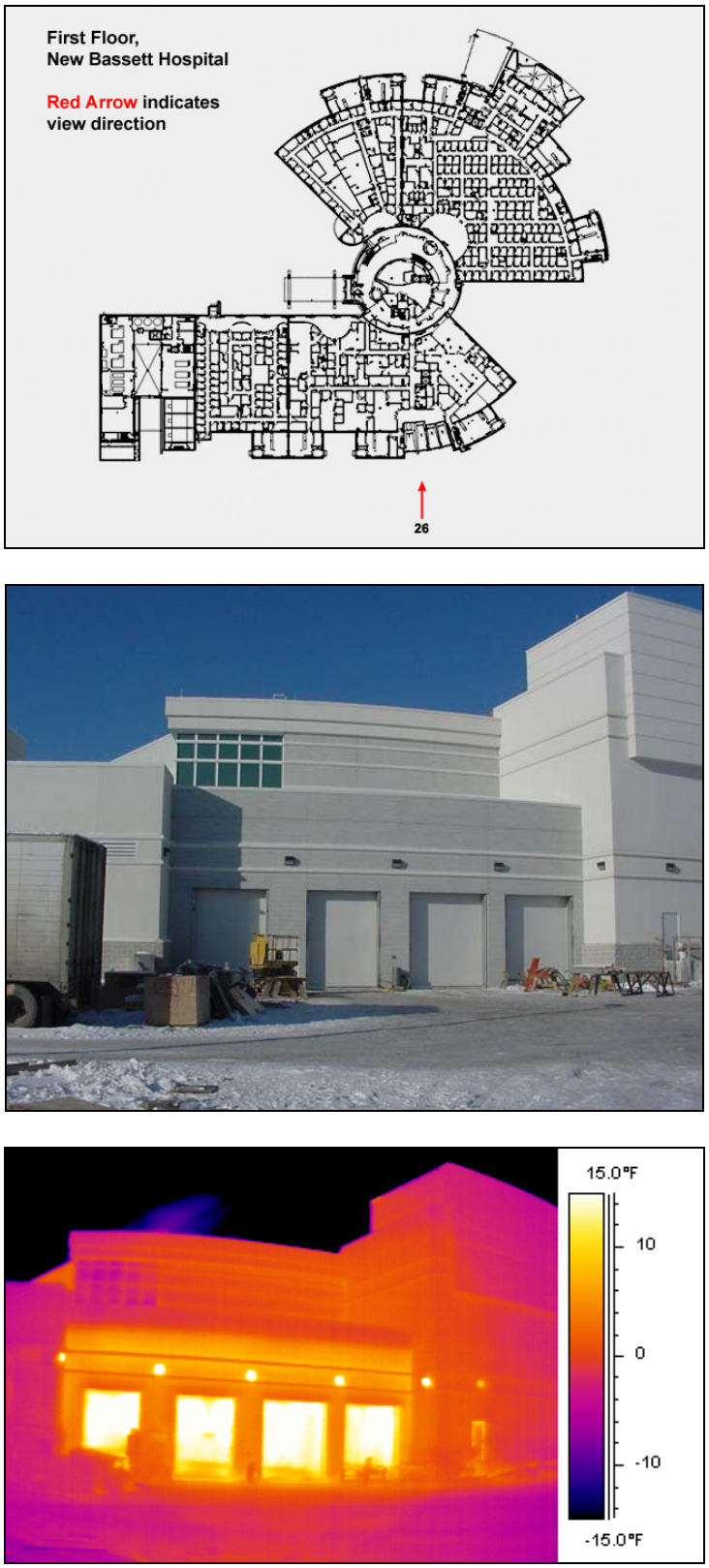
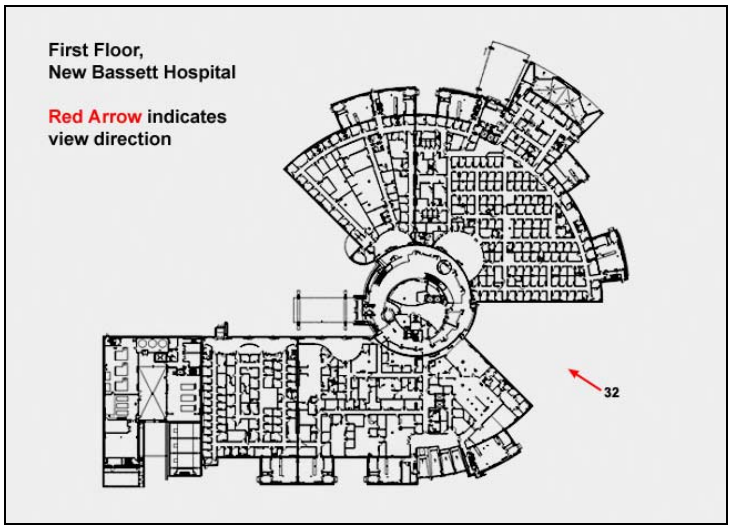


Figure 10. View Number 26 showing visual and thermal imagery at the Loading Dock entrances of the New Bassett Hospital on 18 March 2006.



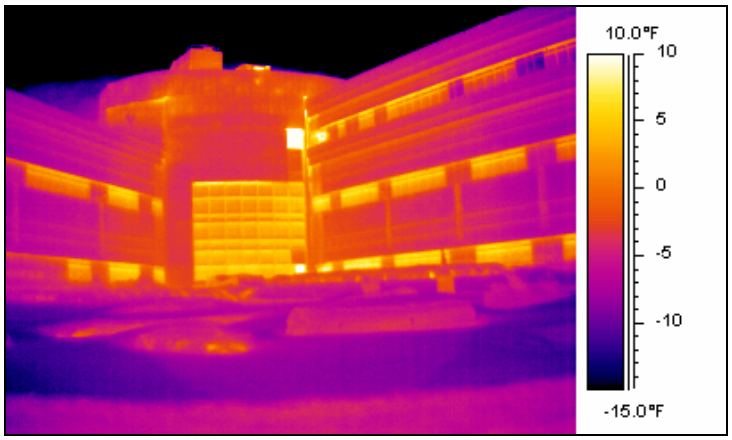


Figure 11. View Number 32 showing visual and thermal imagery at the northeast side of the New Bassett Hospital on 18 March 2006.

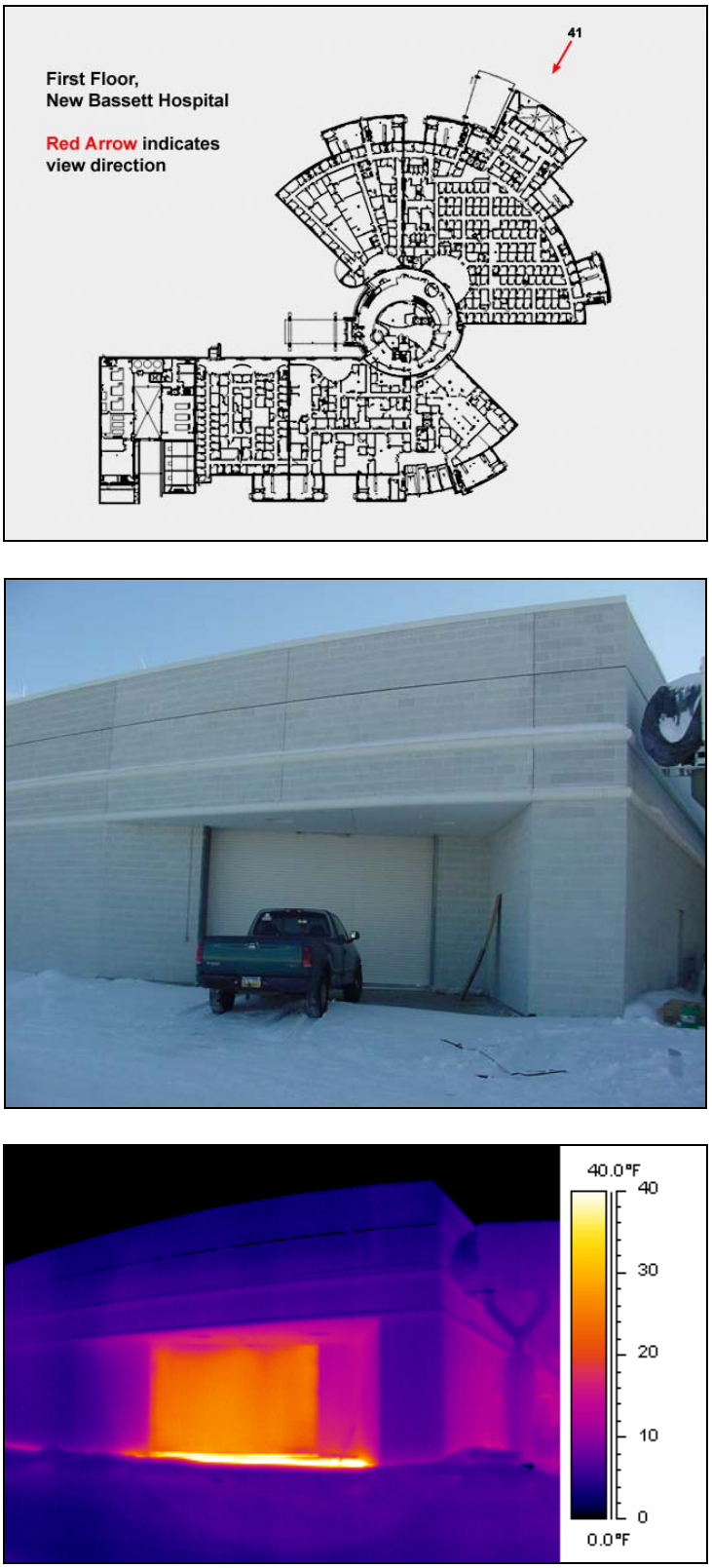


Figure 12. View Number 41 showing visual and thermal imagery at the south ambulance garage door entrance on 18 March 2006.

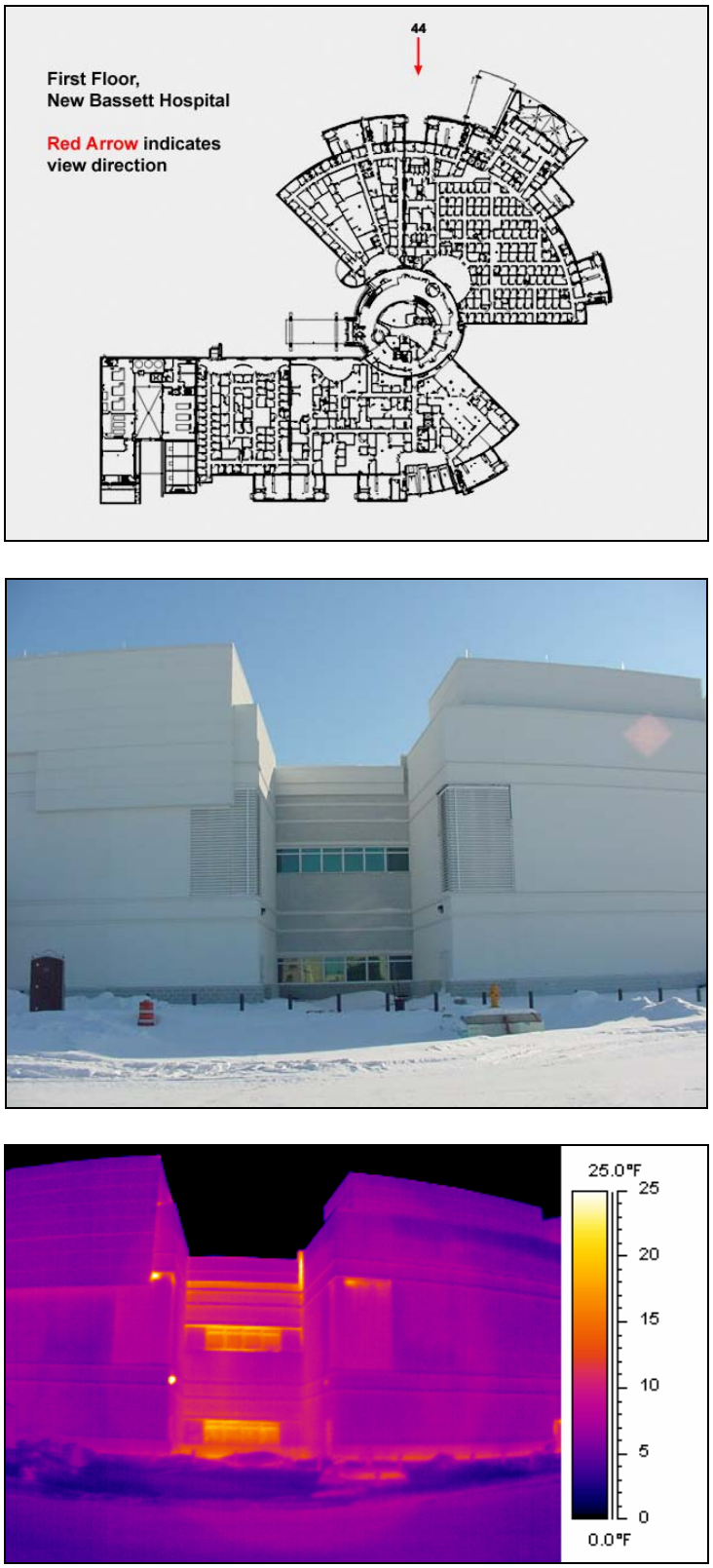


Figure 13. View Number 44 showing visual and thermal imagery at the west side of the New Bassett Hospital near the 10-Line seismic joint on 18 March 2006.

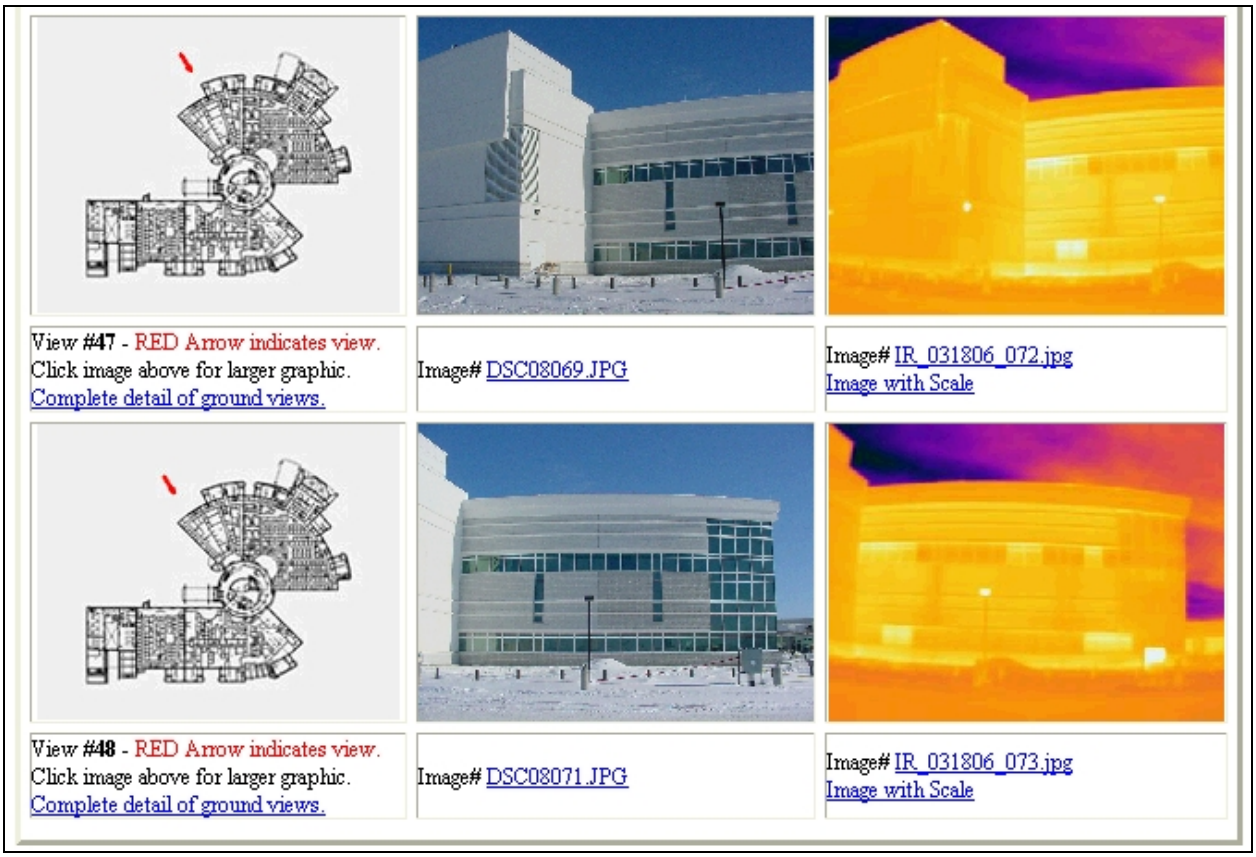


Figure 14. Sample of a portion of the imagery available in the compact disk as Appendix D of this report. Clicking on any of the graphic or visual imagery with take you to a larger version of that image. Clicking on the thermal image or the text "Image with Scale" will take you to a processed version of the IR imagery with a temperature scale as shown in Figure 15 below and in Figures 6 through 13 of this report.

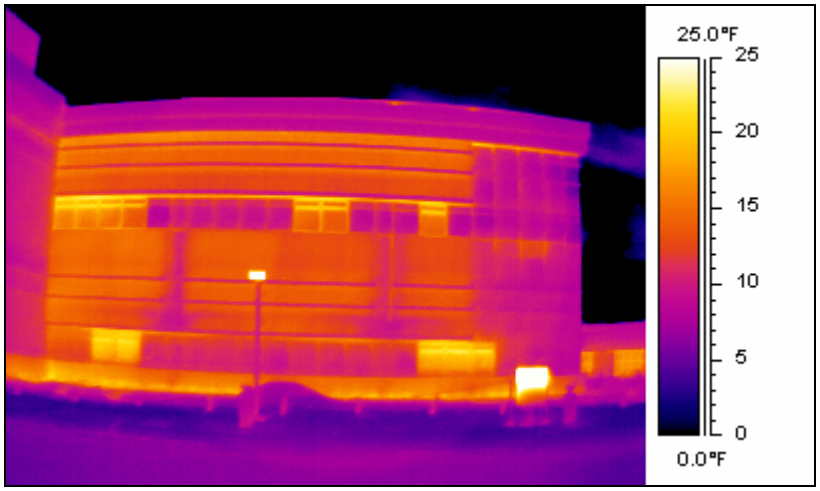


Figure 15. Processed version of thermal image "IR_031806_073.jpg" with a temperature scale. These processed images are saved on the CD as BMP files with the same file name.

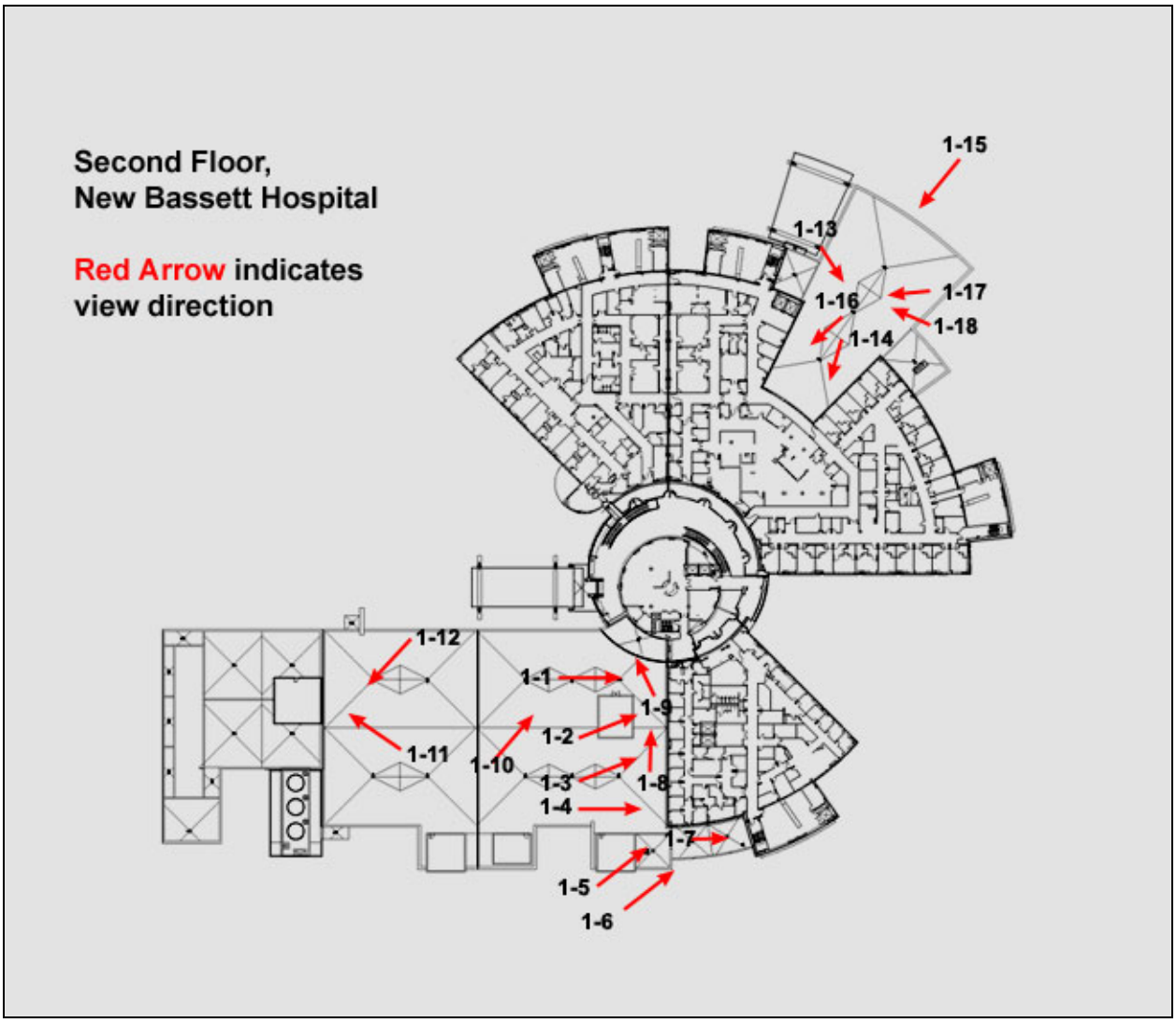


Figure 16. Key of second-floor level exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. This imagery was taken from the first-floor roof level. The north side of the building is at the right side of the figure.

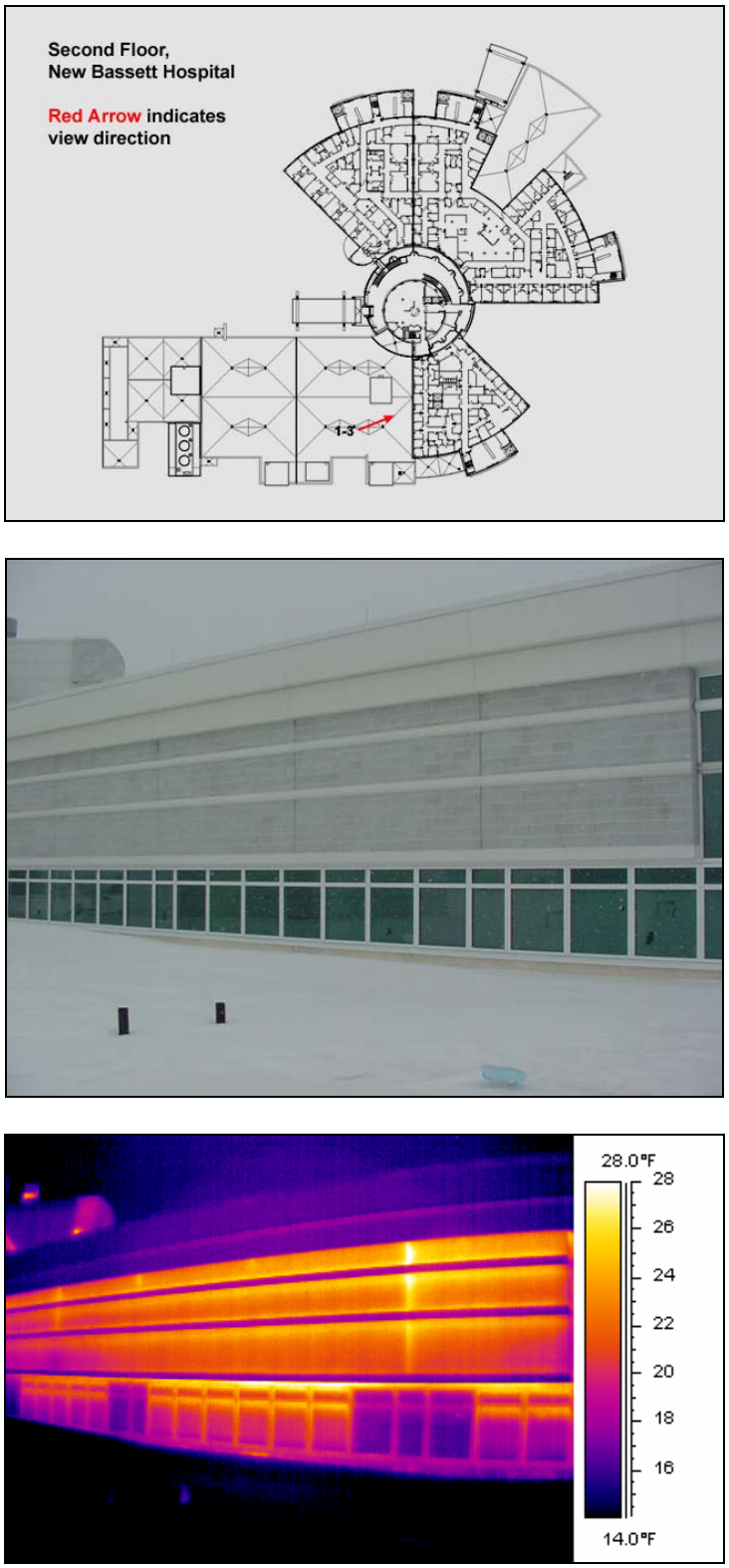


Figure 17. View Number 1-3 showing visual and thermal imagery of south-facing second-floor exterior wall of the Dental Clinic at the New Bassett Hospital on 19 March 2006.

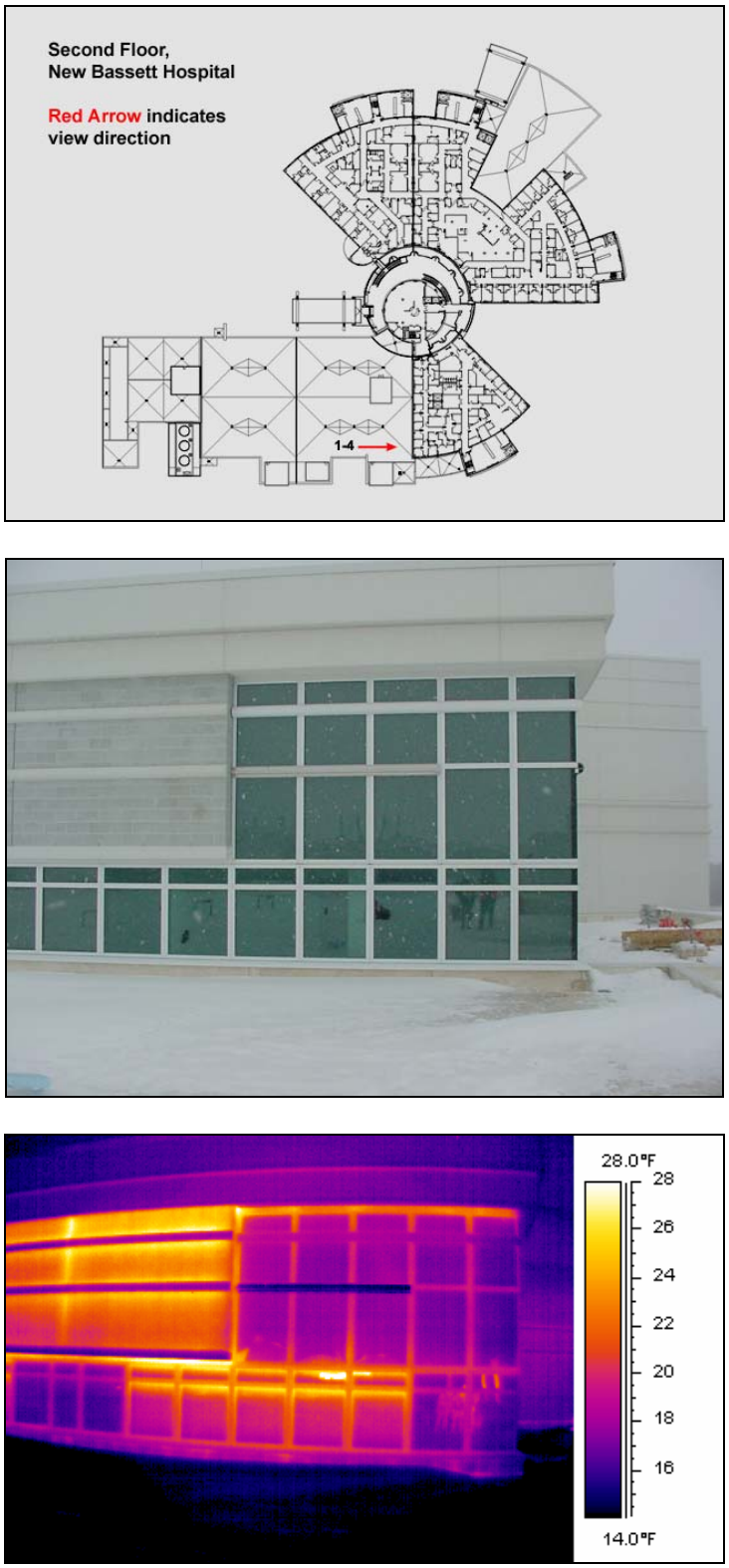


Figure 18. View Number 1-4 showing visual and thermal imagery at the southeast corner of the second-floor exterior wall of the Dental Clinic on 19 March 2006.

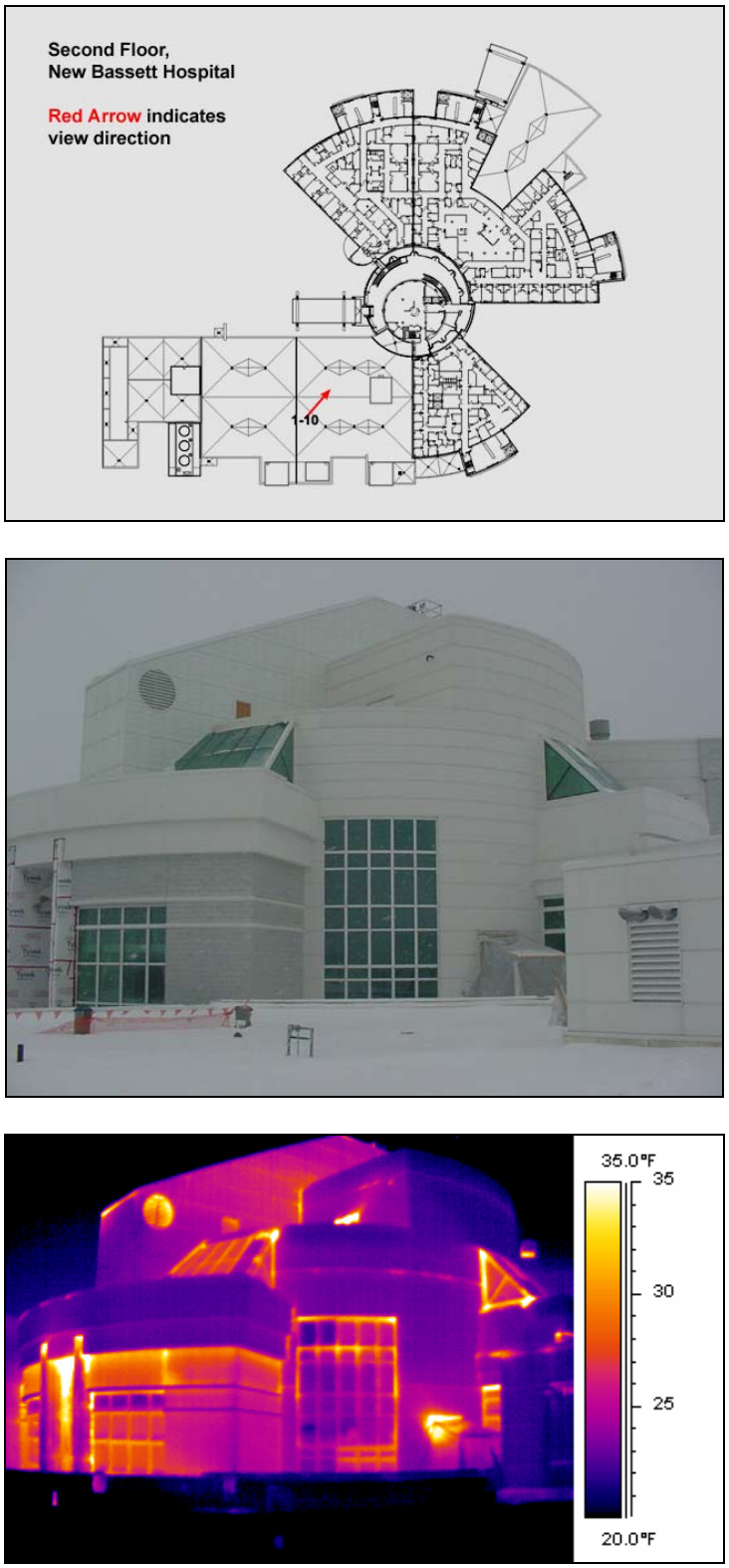


Figure 19. View Number 1-10A showing visual and thermal imagery of southeast-facing portion of the central core of the New Bassett Hospital on 19 March 2006.

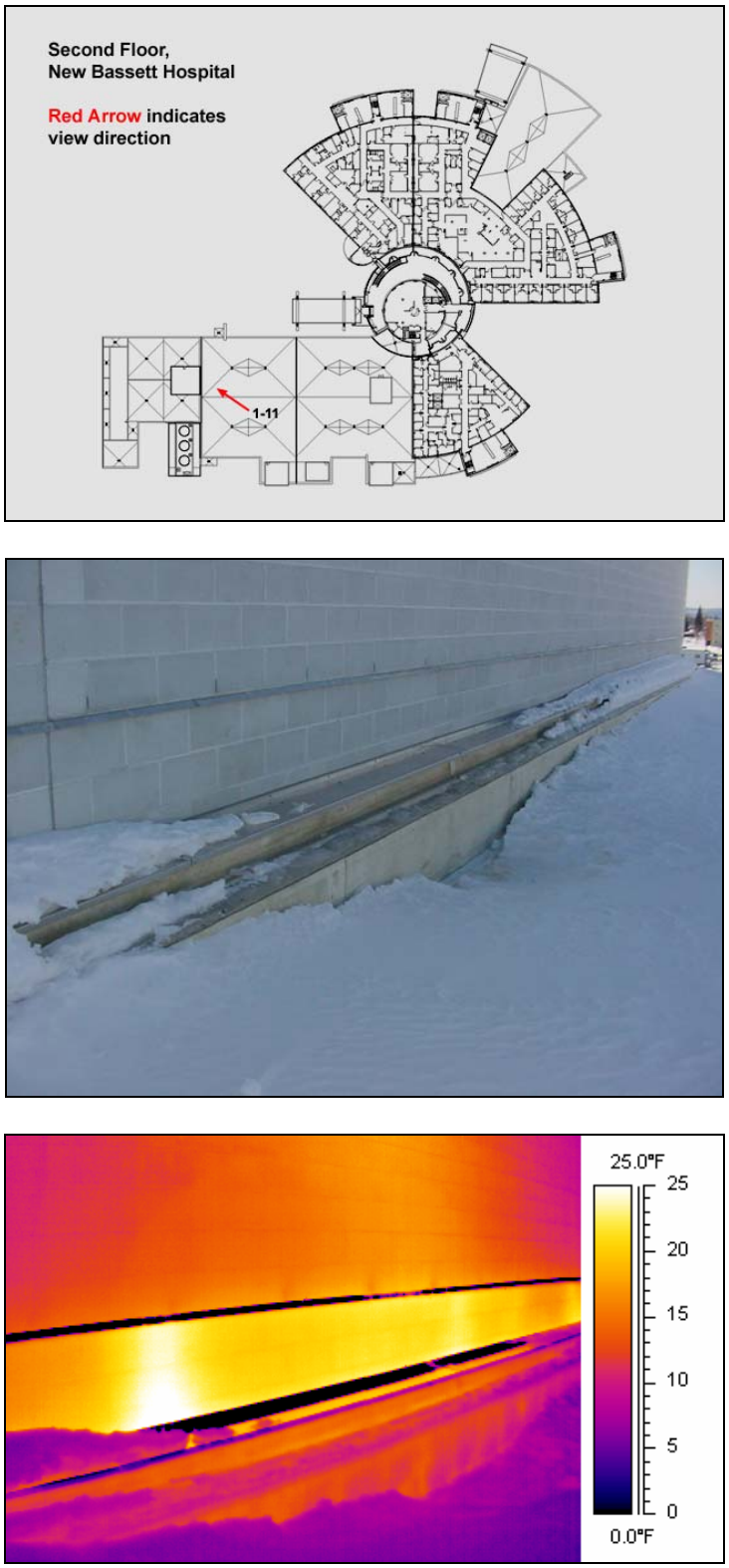


Figure 20. View Number 1-11 showing visual and thermal imagery of the horizontal seismic joint at the 19/20 Line between the VA Clinic and CEP sections of the New Bassett Hospital on 17 March 2006. This was the only portion of this seismic joint not covered by snow.

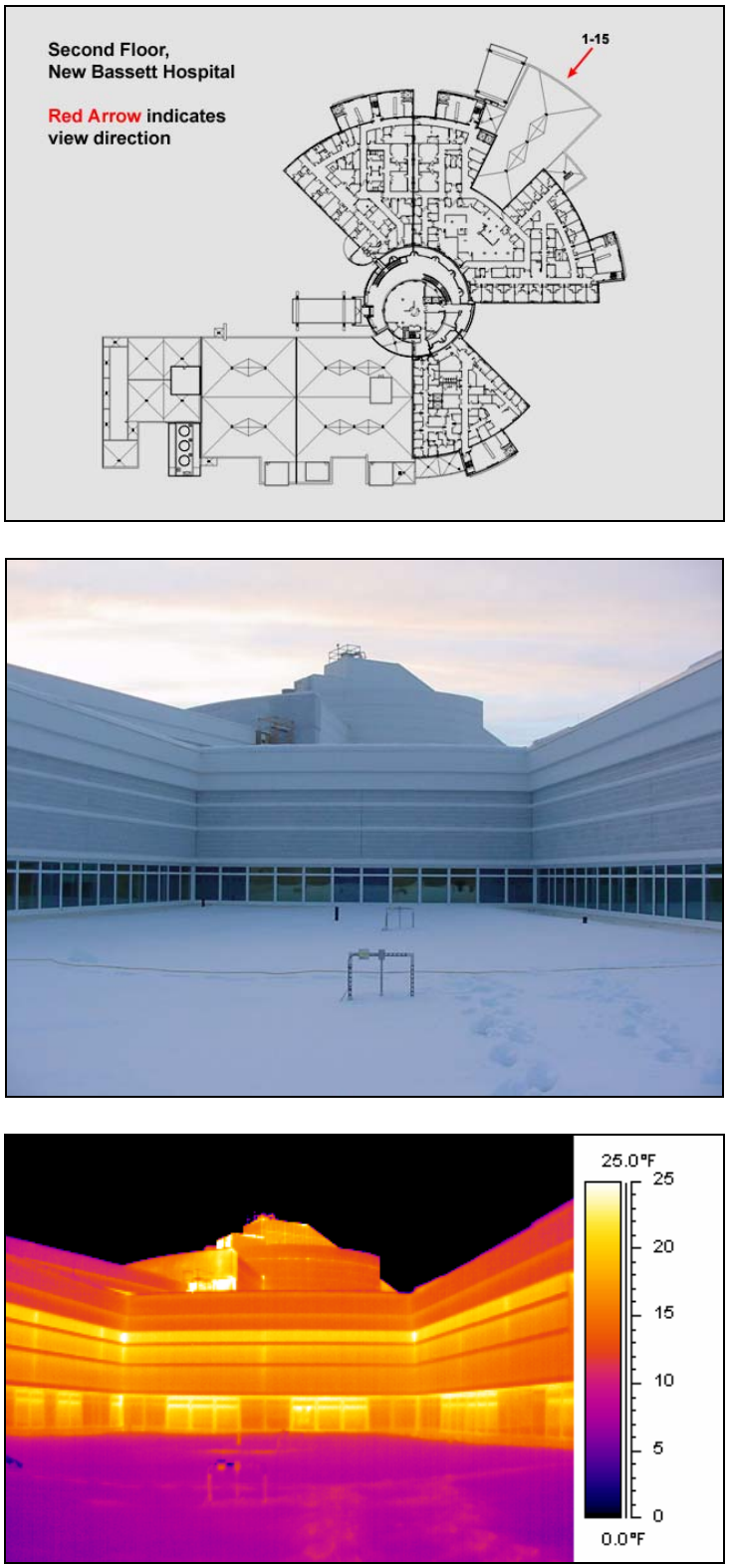
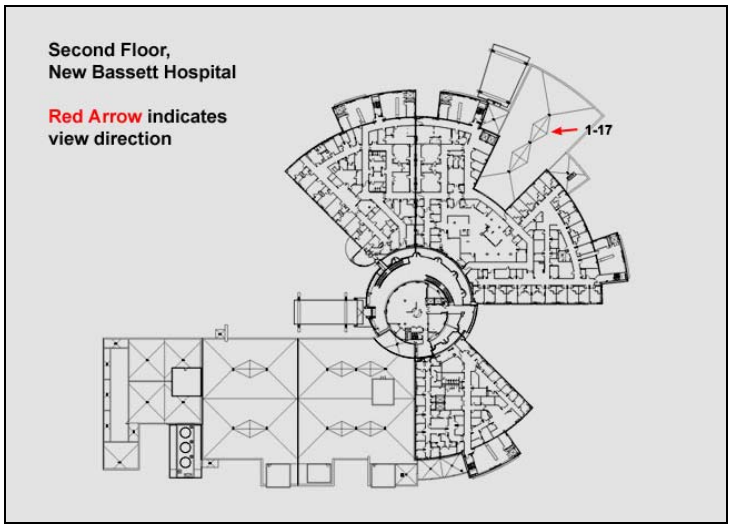


Figure 21. View Number 1-15 showing visual and thermal imagery of second-floor exterior walls on the northwest side of the New Bassett Hospital on 19 March 2006.



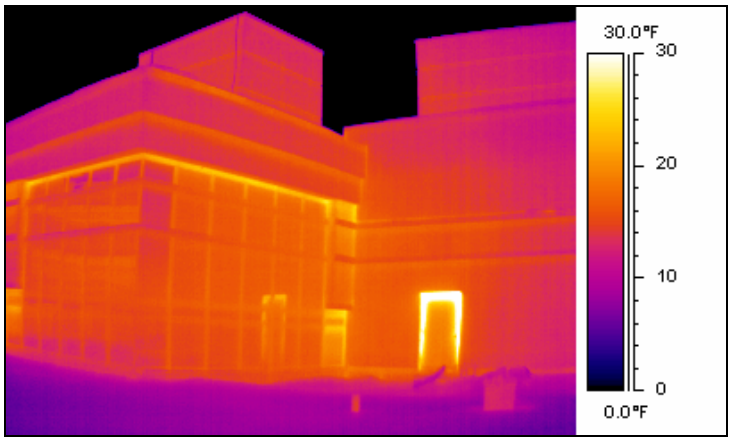


Figure 22. View Number 1-17 showing visual and thermal imagery of second-floor exterior walls and the roof access door at the northwest side of the New Bassett Hospital on 19 March 2006.

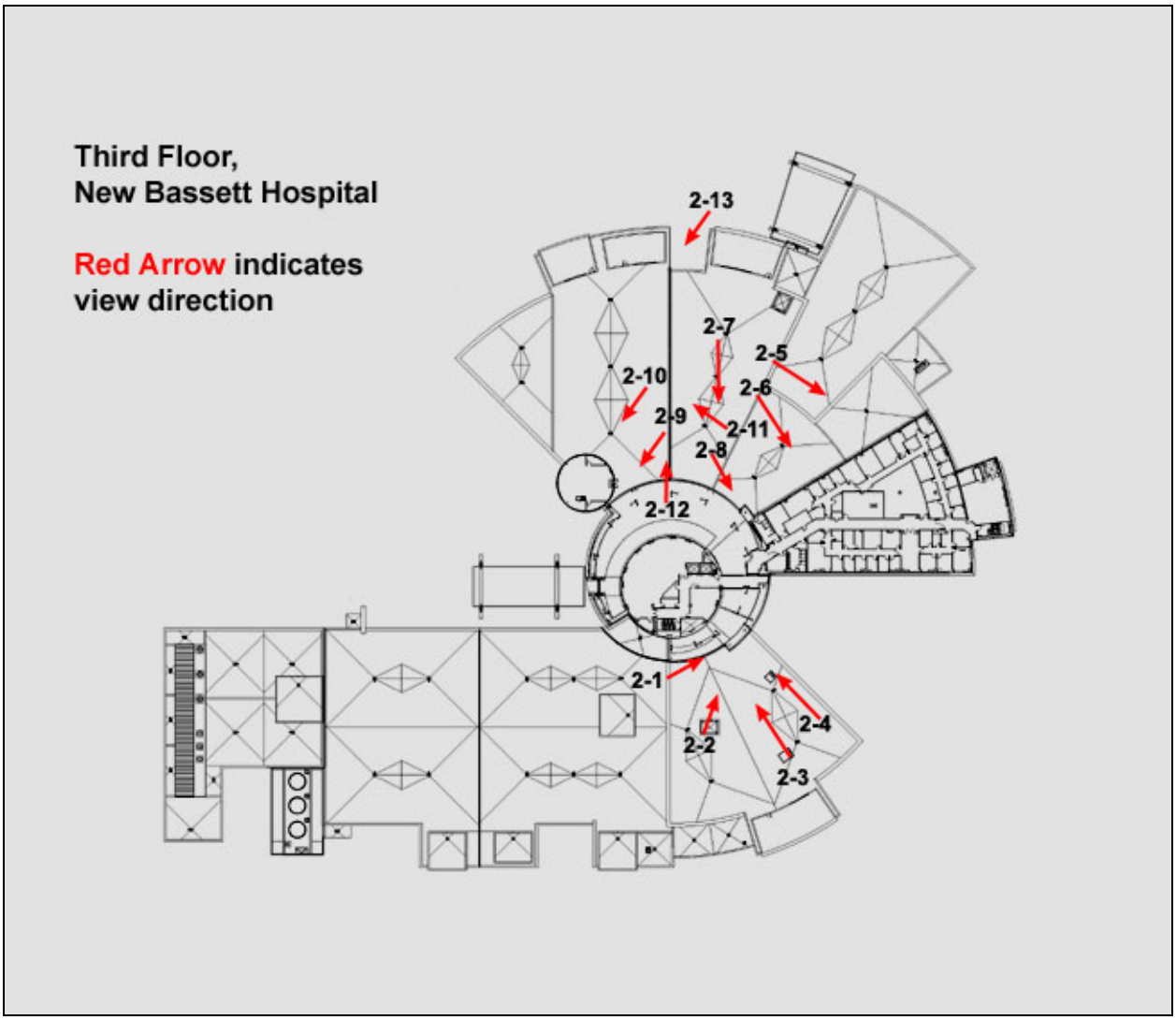


Figure 23. Key of third-floor exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. This imagery was taken from the second-floor roof level. The north side of the building is at the right side of the figure.

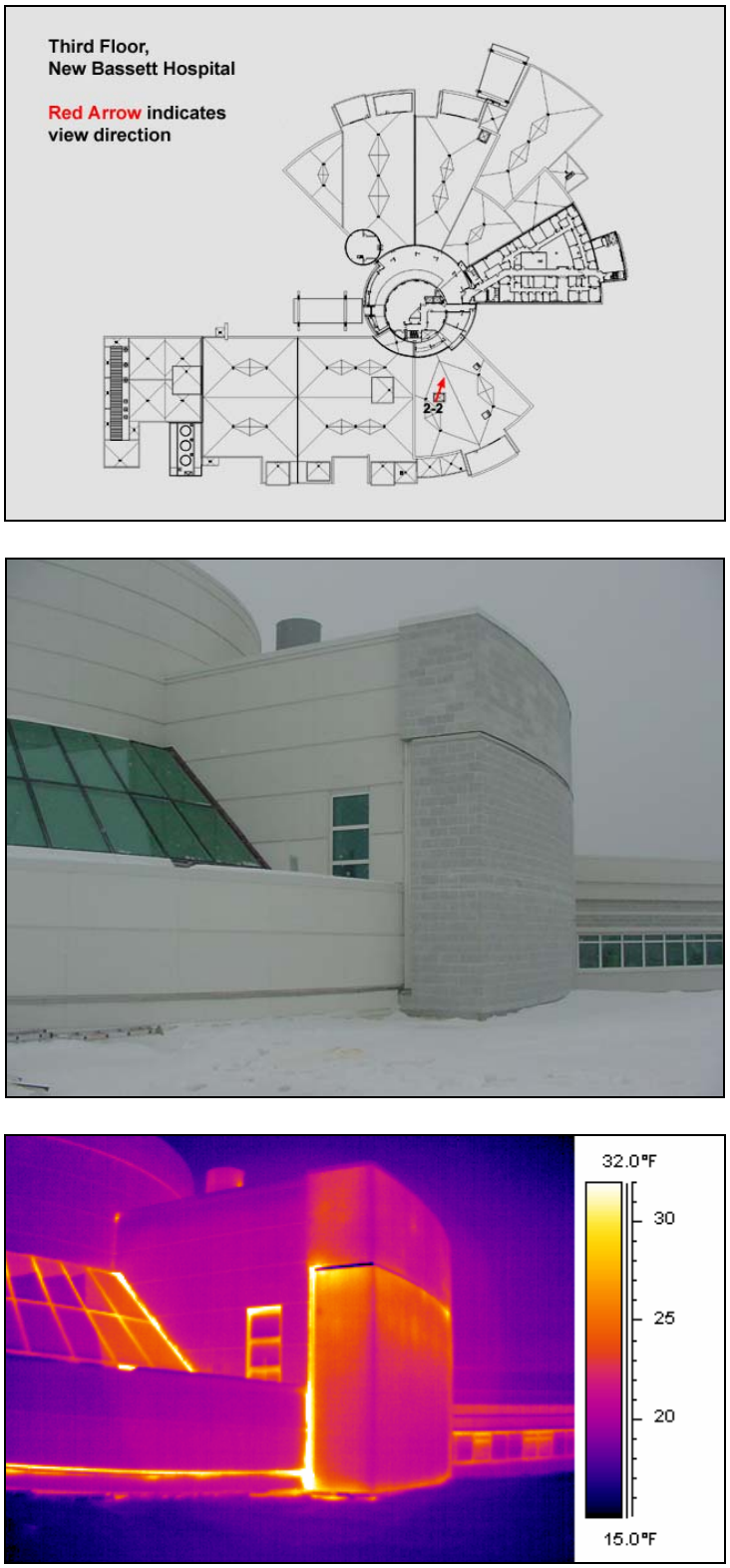


Figure 24. View Number 2-2 showing visual and thermal imagery of third-floor exterior walls and seismic joints at the northeast side of the New Bassett Hospital on 19 March 2006.

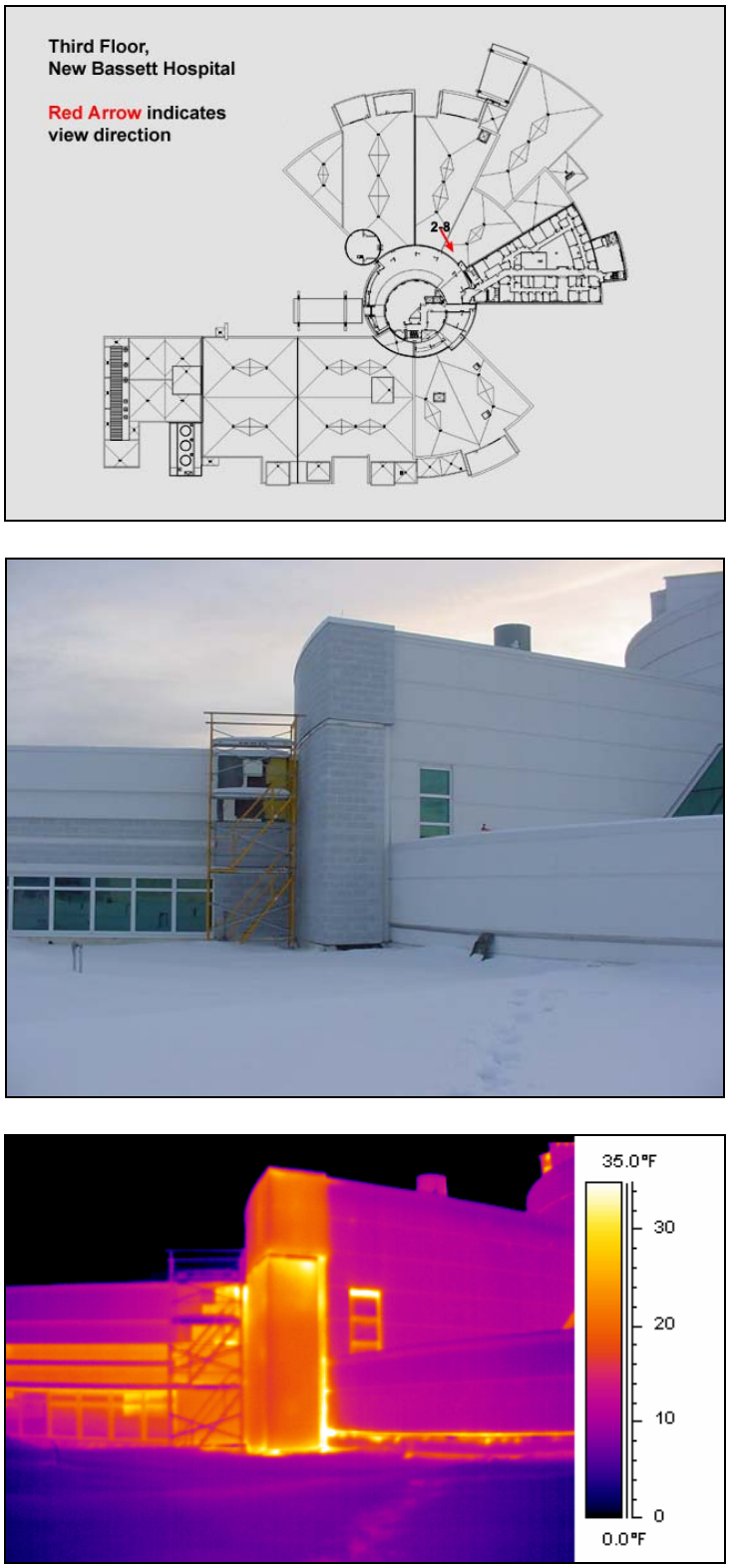
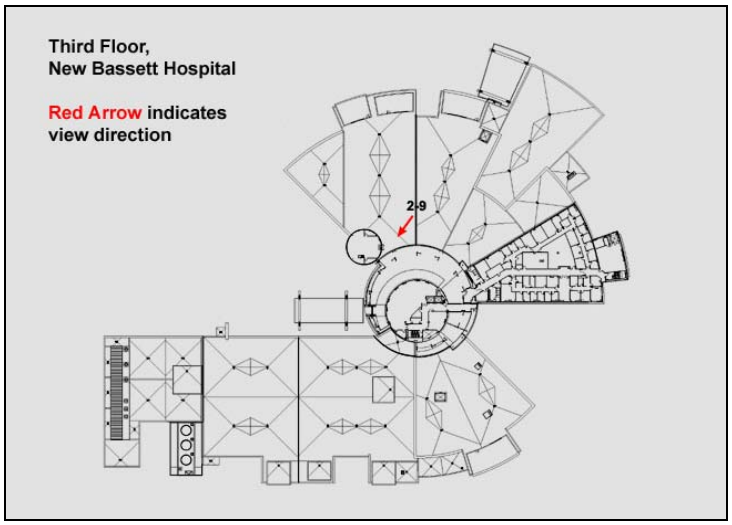
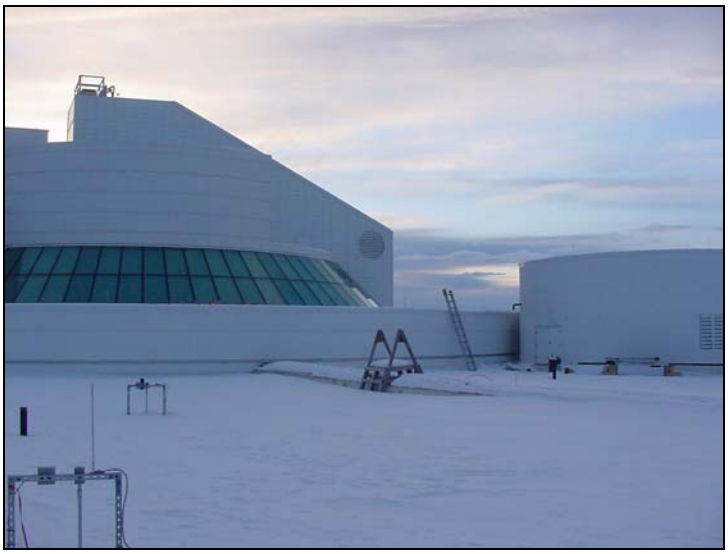


Figure 25. View Number 2-8 showing visual and thermal imagery of third-floor exterior walls and seismic joints at the northwest side of the New Bassett Hospital on 19 March 2006.





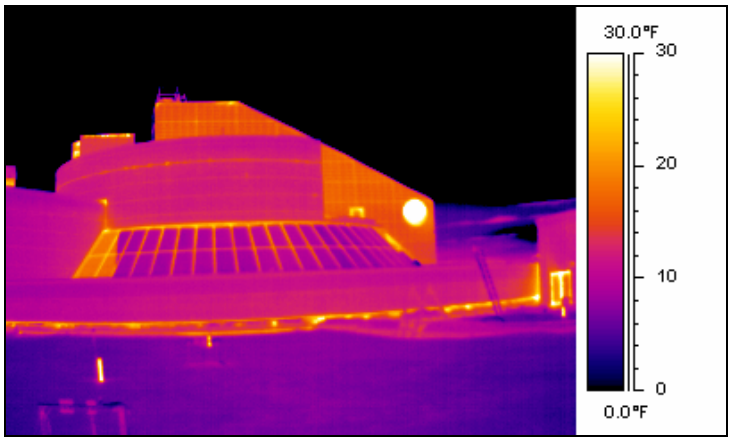
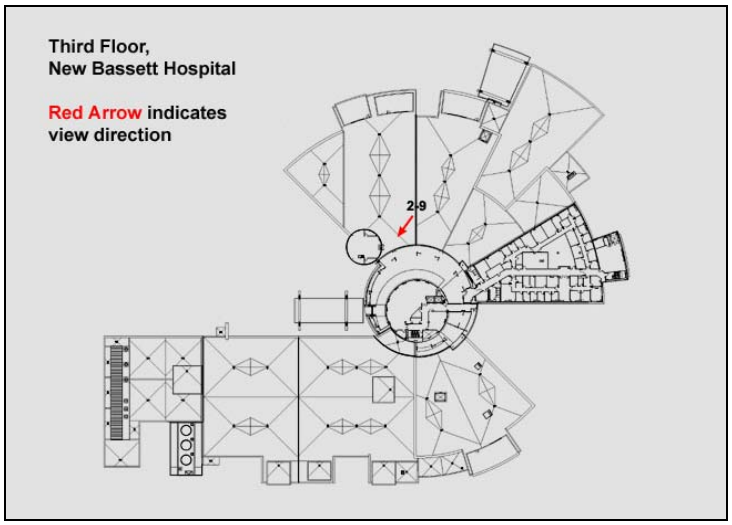


Figure 26. View Number 2-9 showing visual and thermal imagery of third-floor exterior walls, ski slope, skylights, and seismic joints at the west side of the New Bassett Hospital.



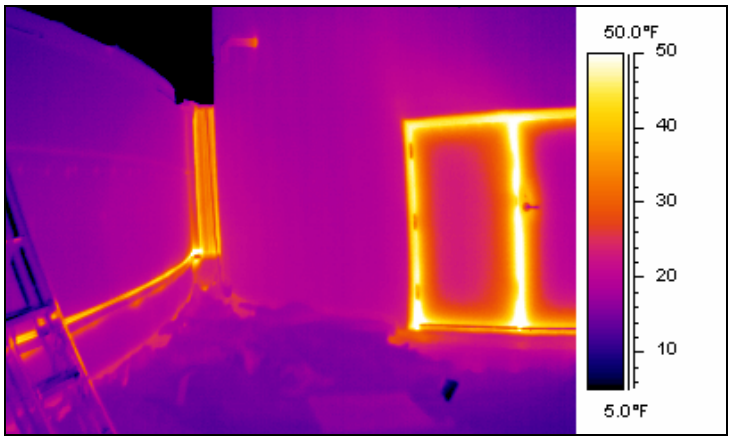


Figure 27. View Number 2-9A showing visual and thermal imagery detail of third-floor exterior walls, seismic joints, and an exterior door. The view is looking southeast from the second-floor roof.

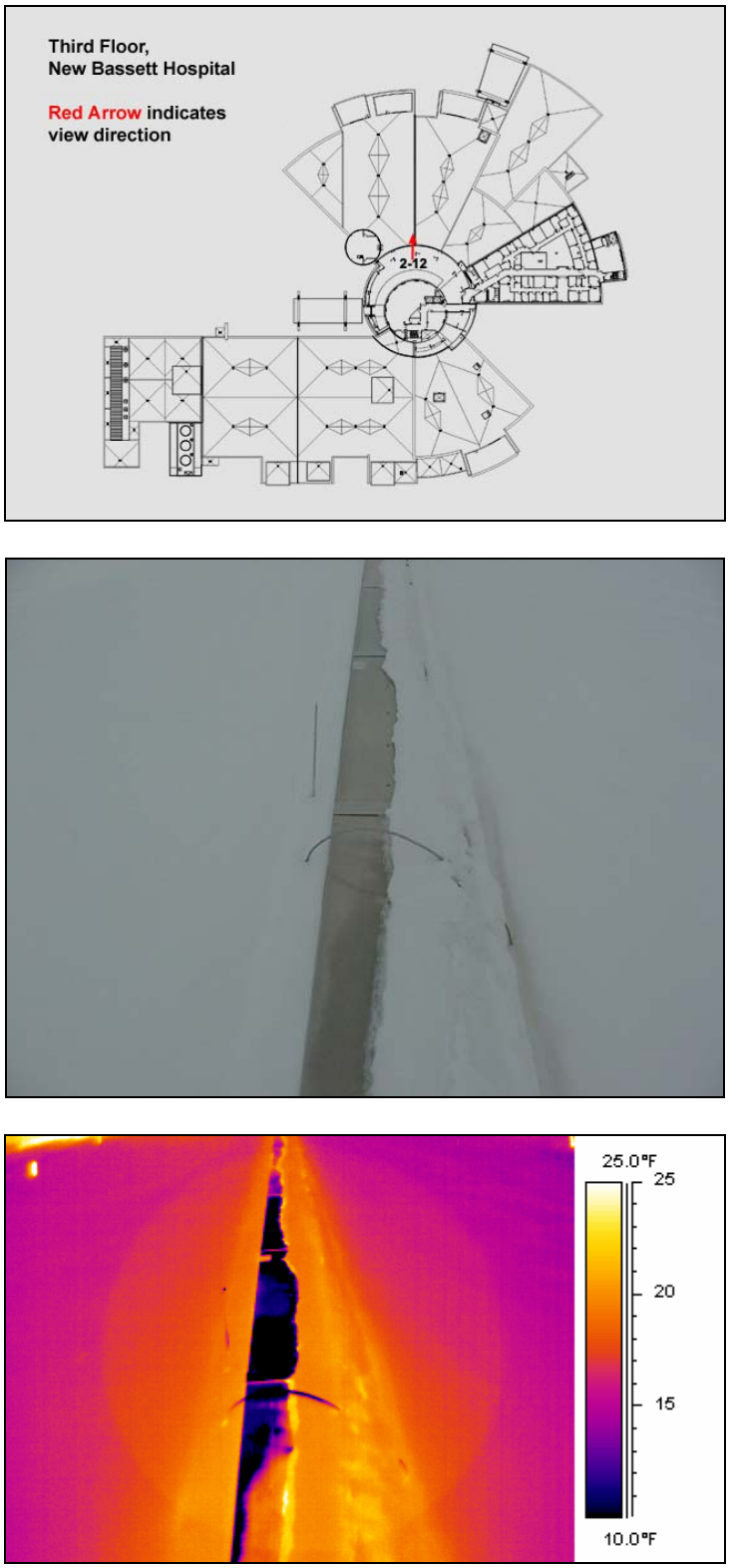
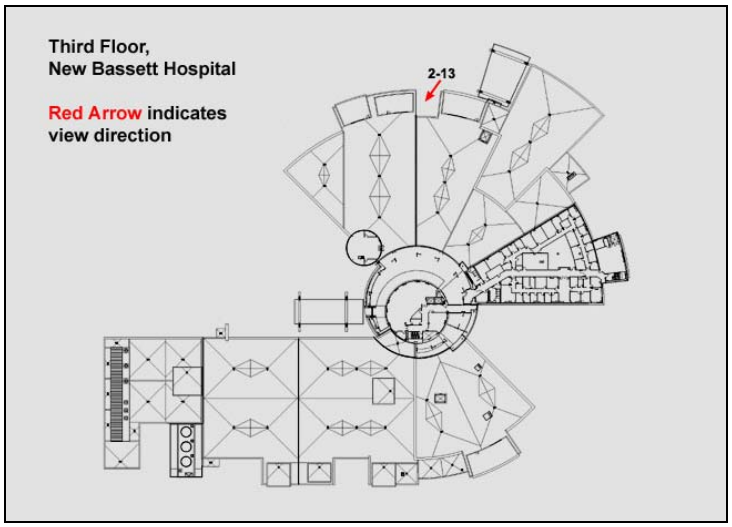


Figure 28. View Number 2-12A showing visual and thermal imagery of the 10-Line seismic joint on the second-floor roof of the New Bassett Hospital.



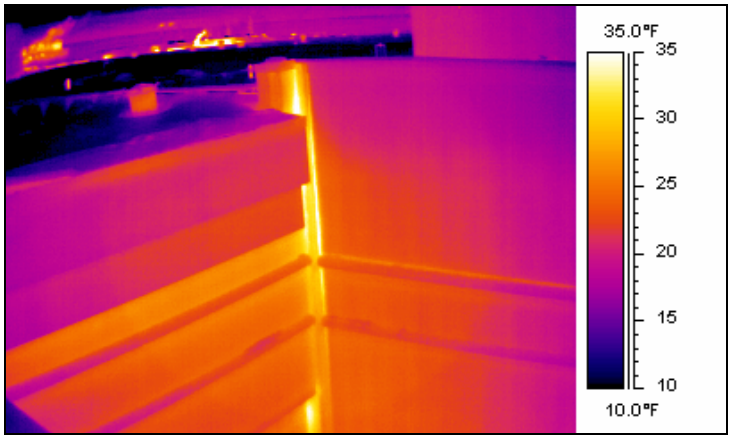


Figure 29. View Number 2-13 showing visual and thermal imagery at the 10-Line seismic joint. The view is of exterior walls and seismic joint below looking down from the second-floor roof.

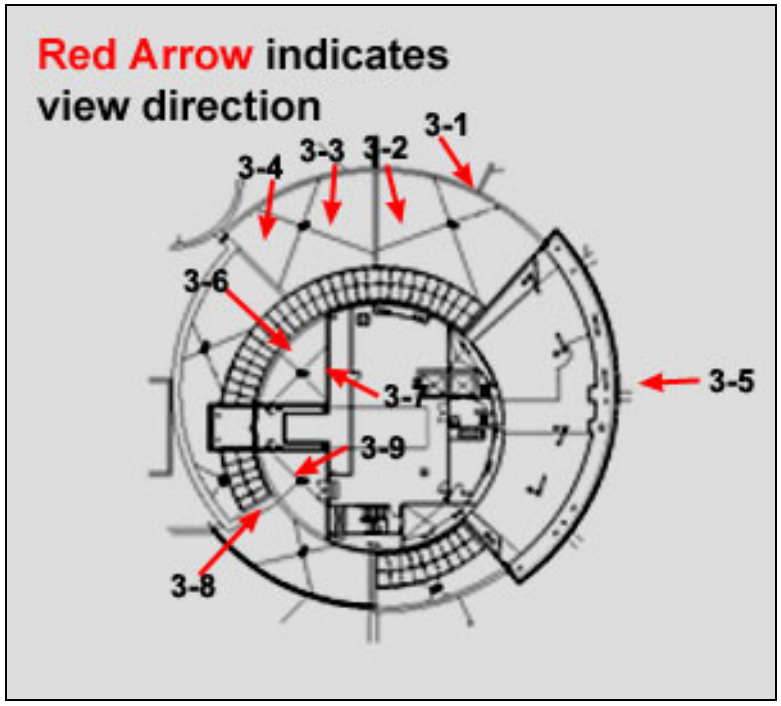
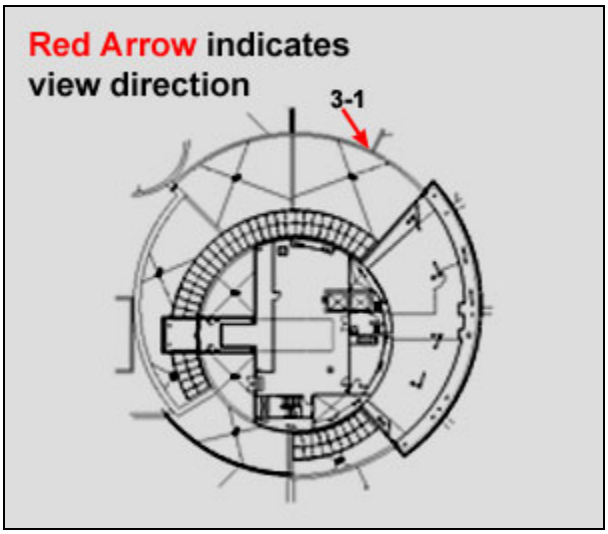


Figure 30. Key of higher-level exterior imagery views showing the view direction for visual and thermal imagery obtained at the New Bassett Hospital. This imagery was taken from several roof levels. The north side of the building is at the right side of the figure.



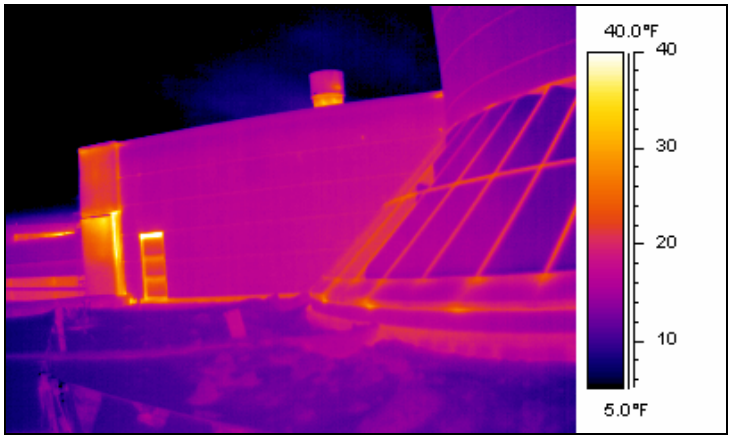
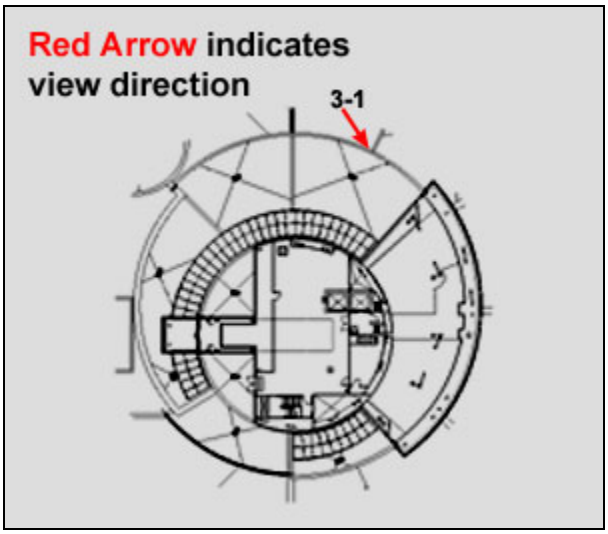


Figure 31. View Number 3-1 showing visual and thermal imagery of higher exterior walls, skylights, and seismic joints at the northwest side of the New Bassett Hospital.



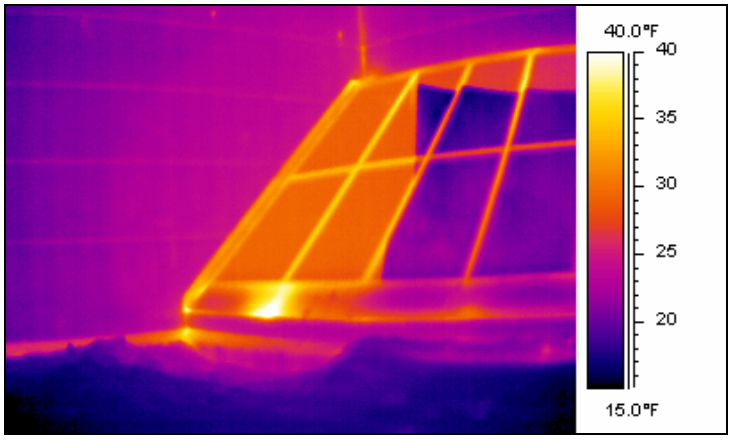
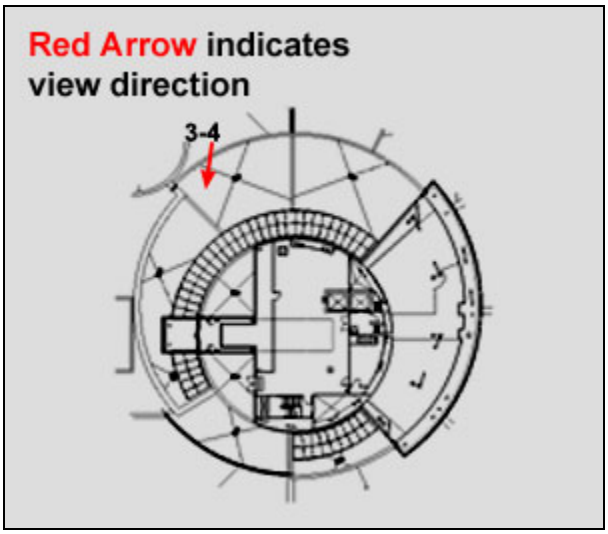


Figure 32. View Number 3-1B showing visual and thermal imagery of exterior walls and skylight at the northwest side of the New Bassett Hospital.



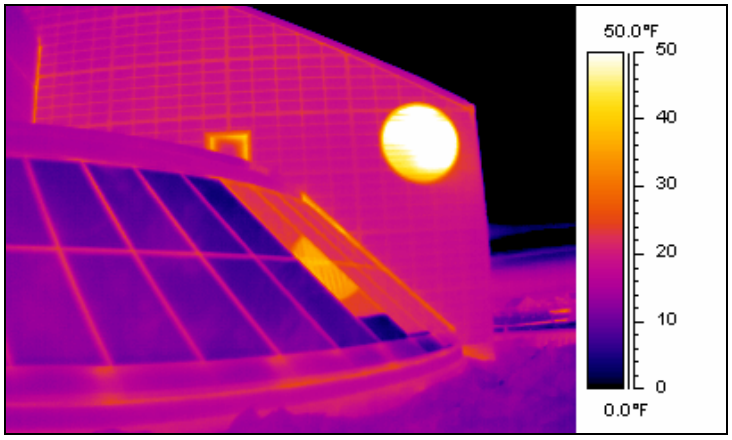
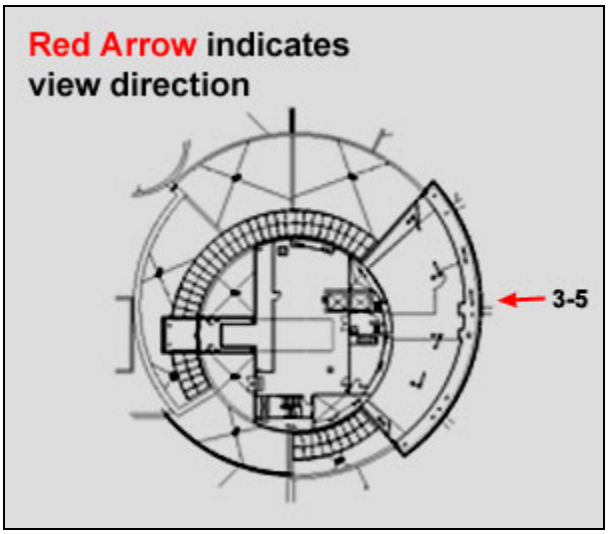


Figure 33. View Number 3-4 showing visual and thermal imagery of the skylight and ski slope at the west side of the New Bassett Hospital on 19 March 2006.



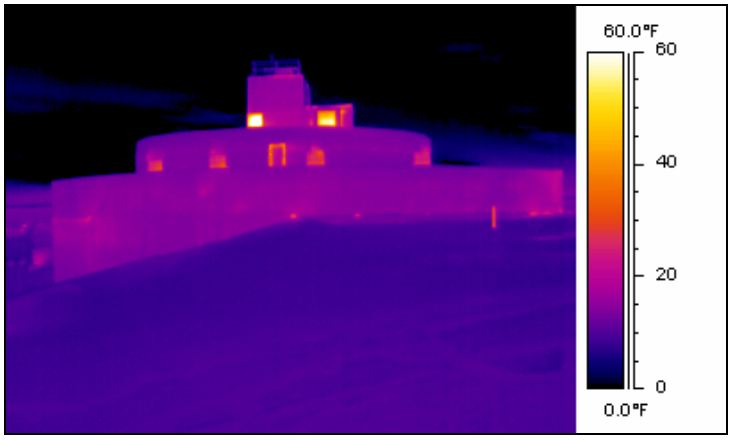
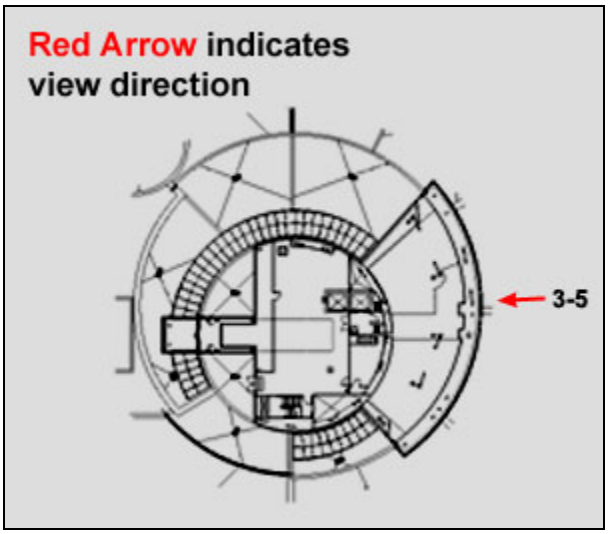


Figure 34. View Number 3-5 showing visual and thermal imagery of higher exterior walls at the north side of the New Bassett Hospital on 19 March 2006.



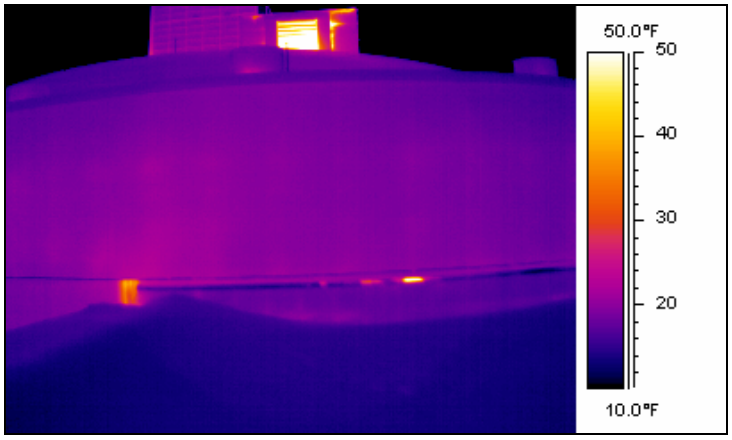


Figure 35. View Number 3-5A showing visual and thermal imagery of higher exterior walls and the seismic joint at the north side of the New Bassett Hospital on 19 March 2006.

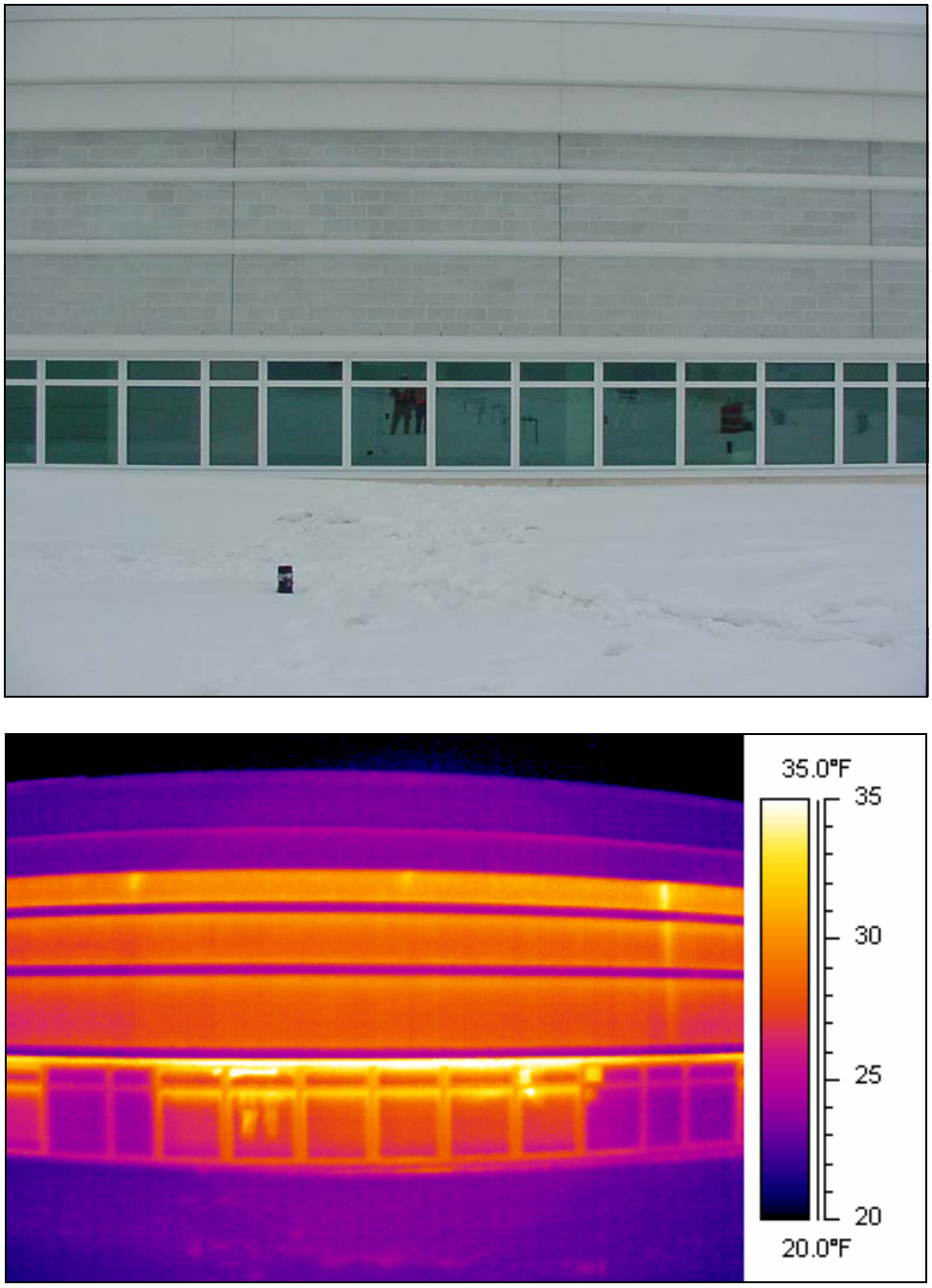


Figure 36. Window study at the south-facing second-floor exterior wall of the Dental Clinic (see Fig. 17 for location) showing visual and thermal imagery of visual windows on 21 March 2006.

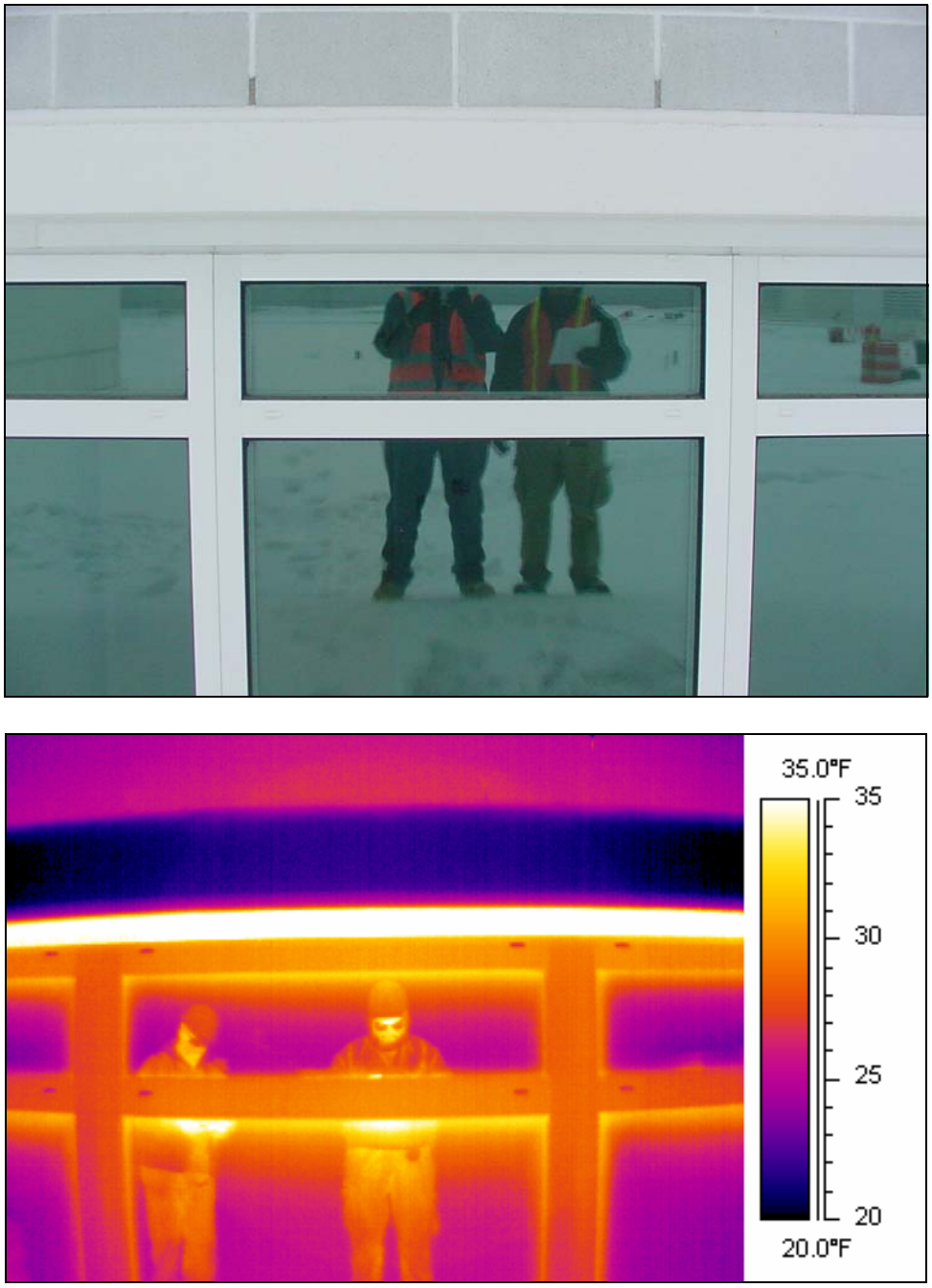


Figure 37. Close-up of windows in Figure 36 showing the warm header over visual windows.

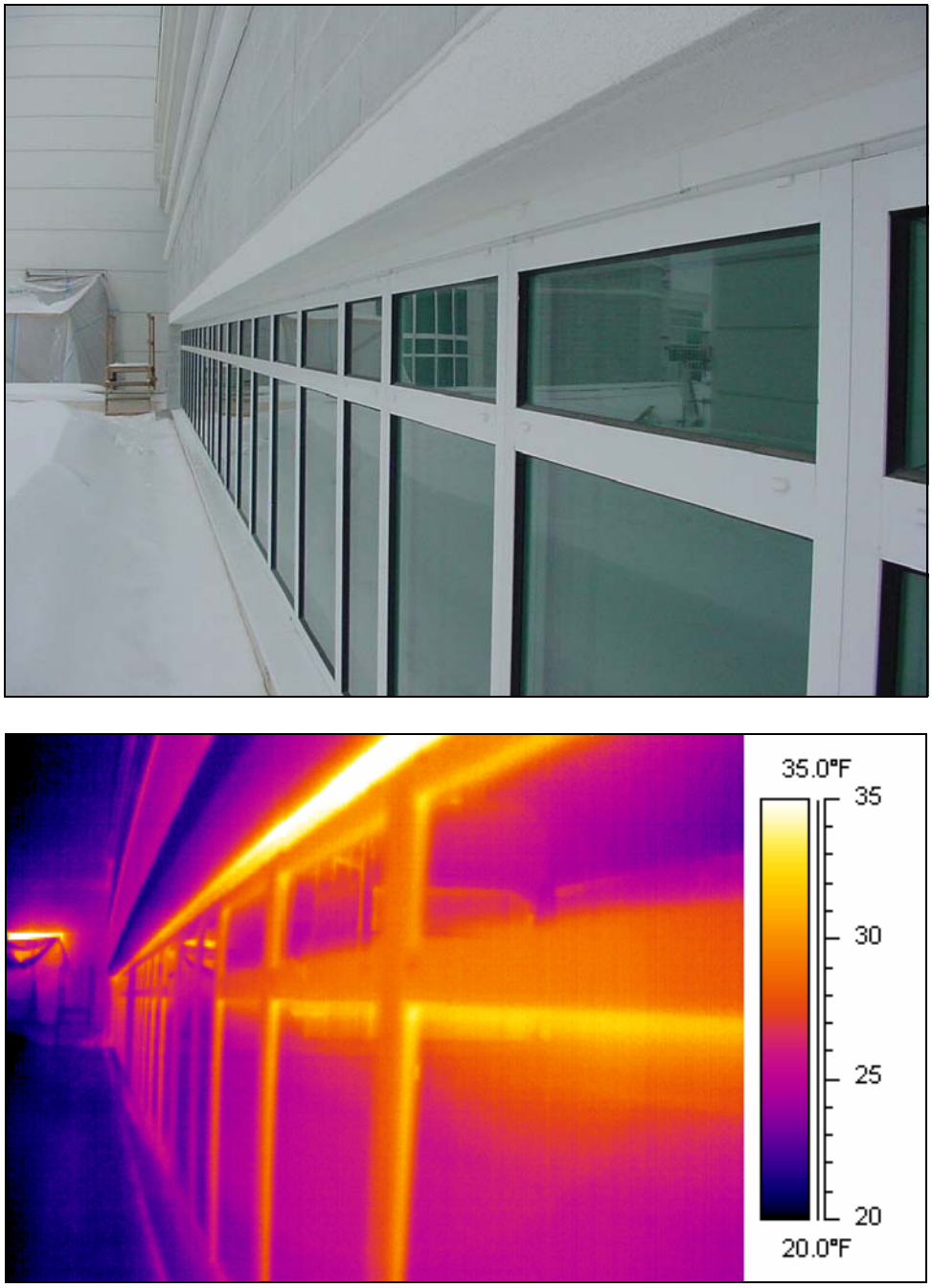
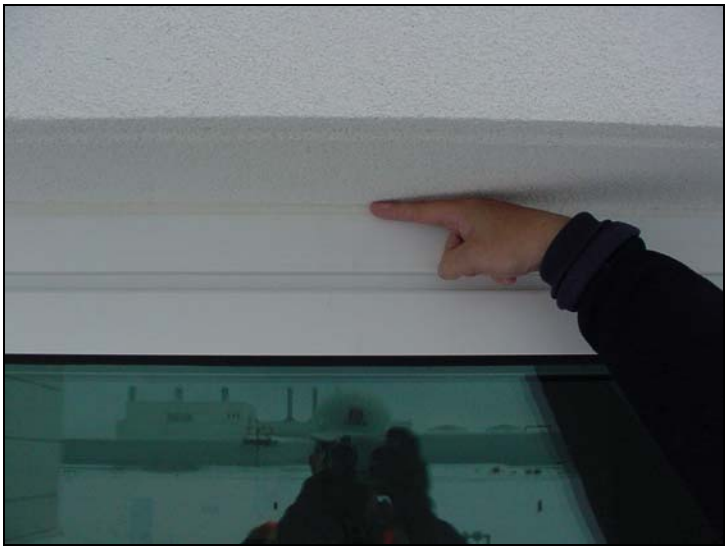


Figure 38. View looking west along the visual windows shown in Figure 36. Heat loss through window header is clearly visible.



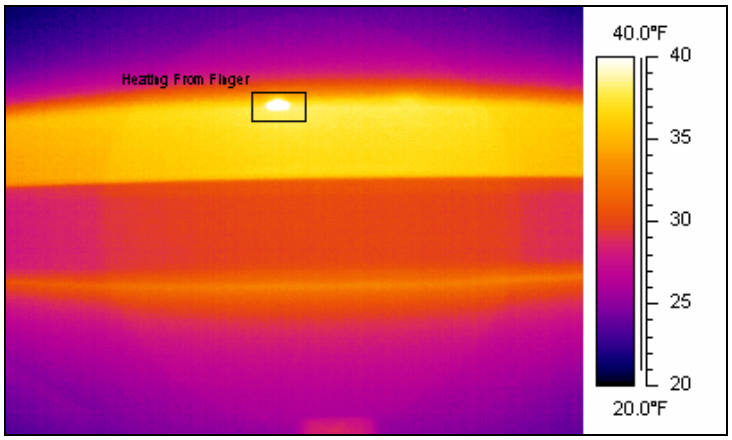


Figure 39. Detail showing heat loss at window header with the header location indicted by placing a warm finger on the header and removing it prior to taking thermal image.

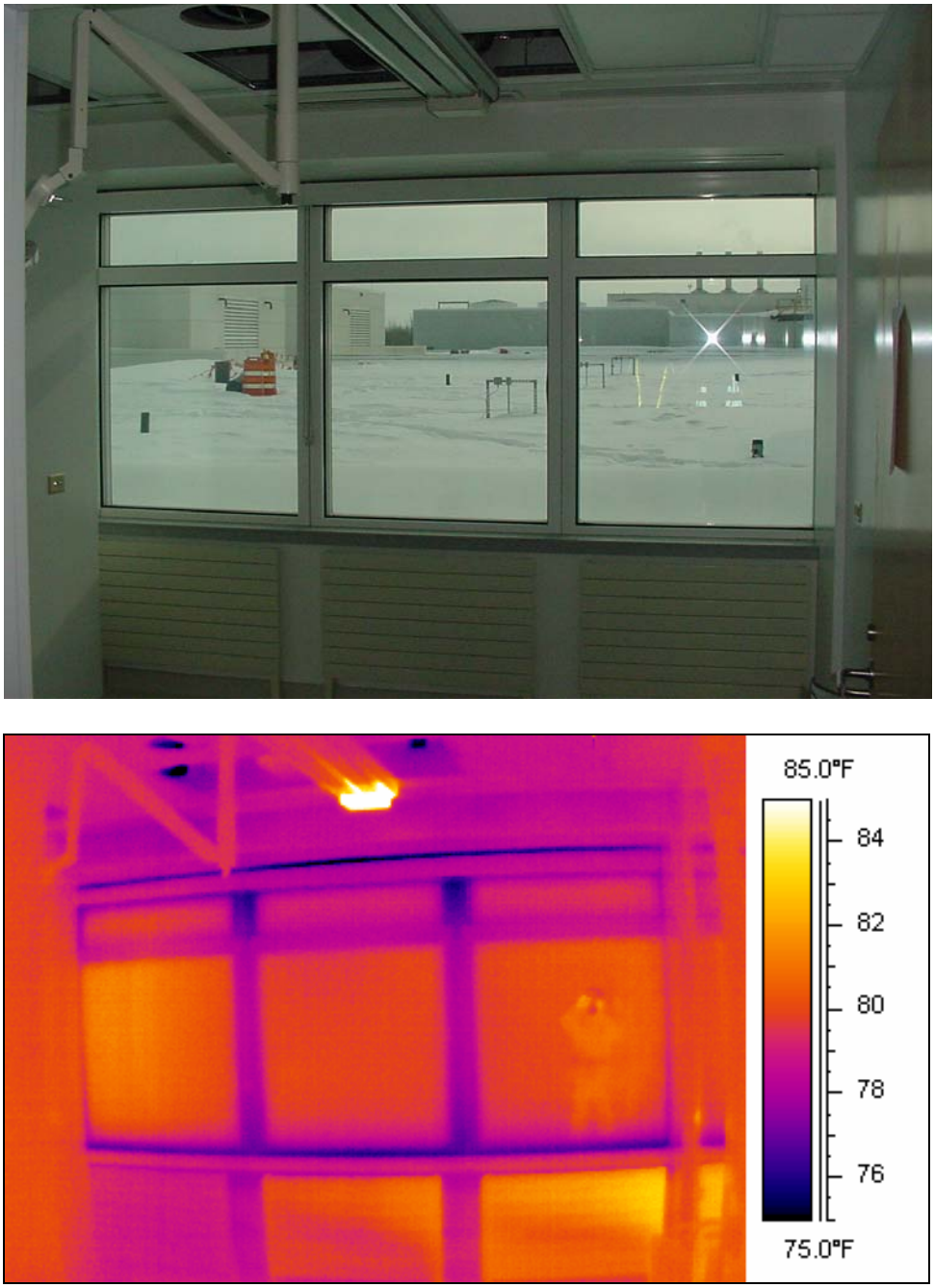


Figure 40. View from inside Room 239-20 looking out of the visual windows shown in Figure 36. This imagery was taken at about 1430 hours on 20 March 2006.

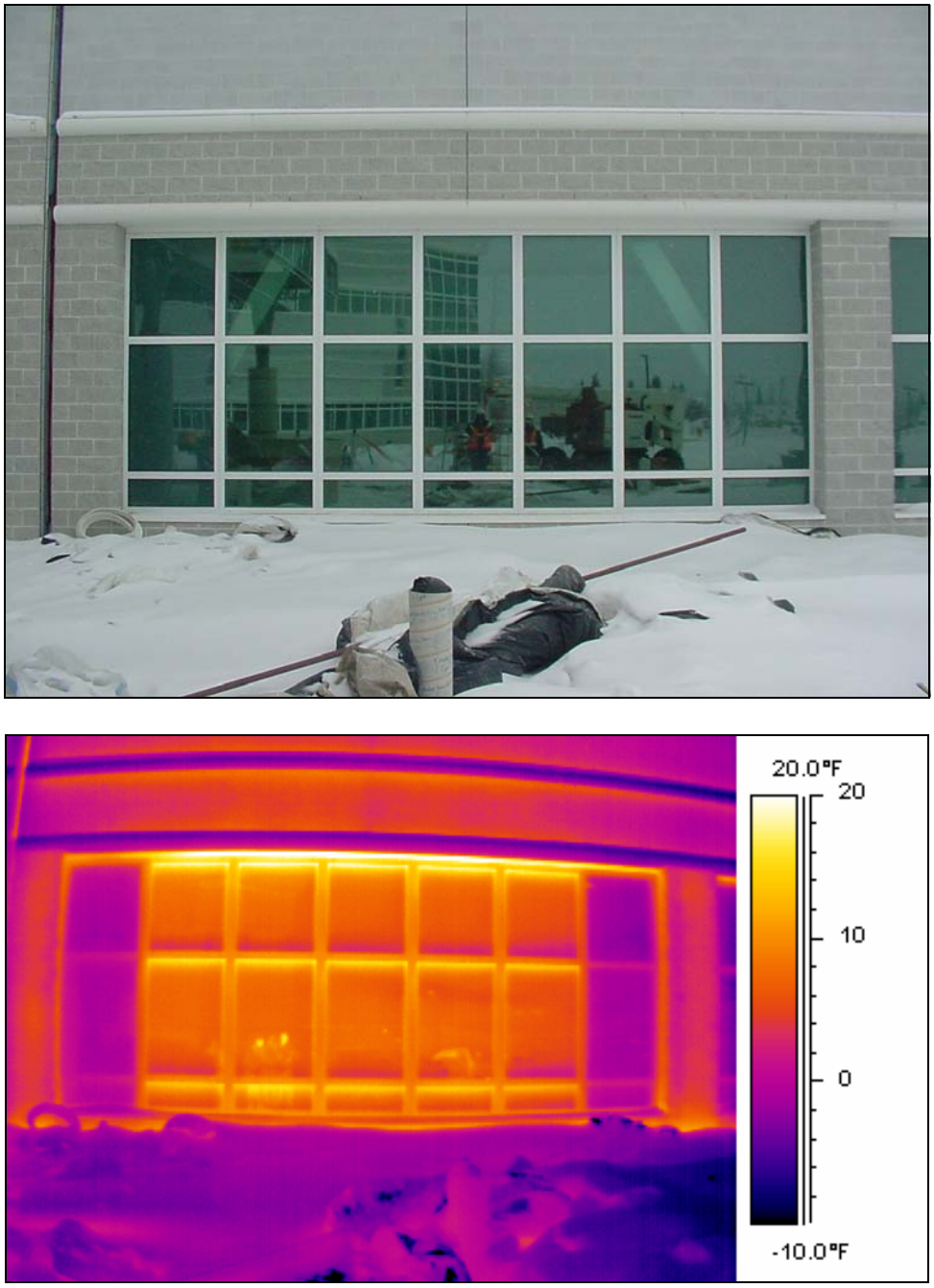


Figure 41. Close-up of the storefront windows shown in View Number 7 (Fig. 5 and App. D). Higher heat loss through the header over these windows is clearly visible as a bright line. The thermal imagery was obtained early Saturday morning (18 March 2006).

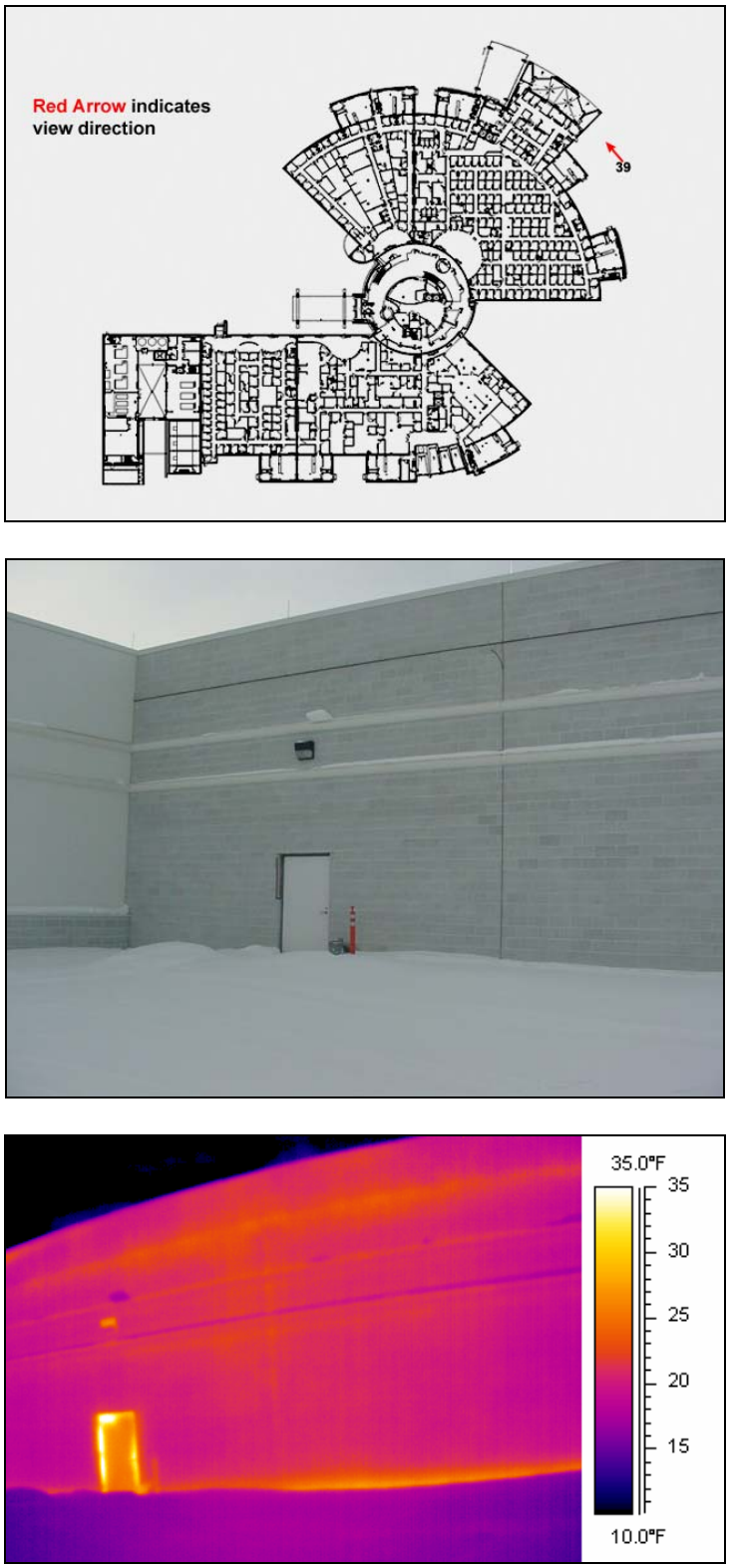
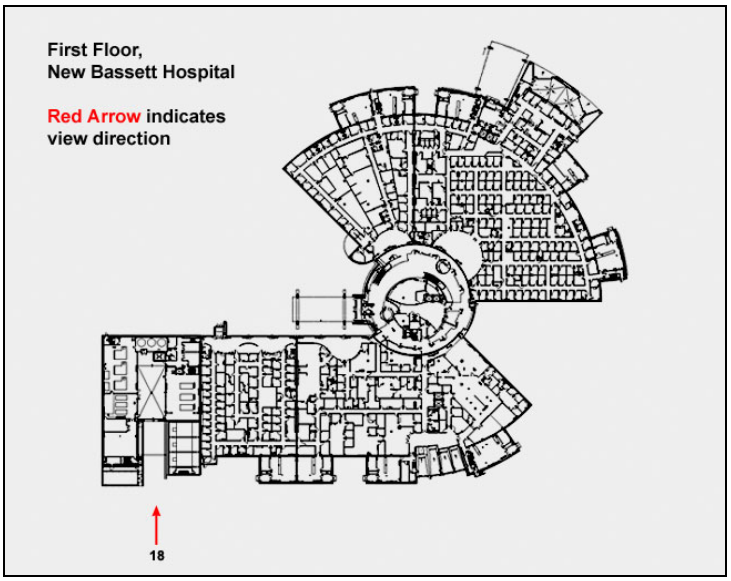


Figure 42. Visual and thermal imagery of personnel door shown in View Number 39 (Fig. 5 and App. D) on 20 March 2006. Heat loss around door frame is typical of exterior doors at this hospital.



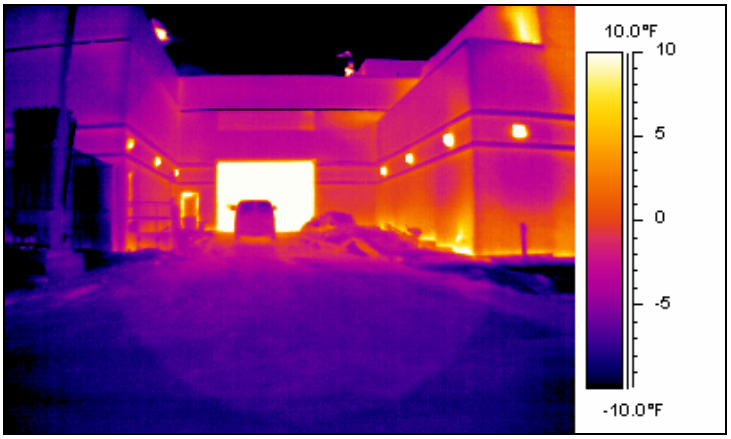


Figure 43. View Number 18 showing visual and thermal imagery of garage and personnel doors to the mechanical room at the east side of the New Bassett Hospital on 18 March 2006.

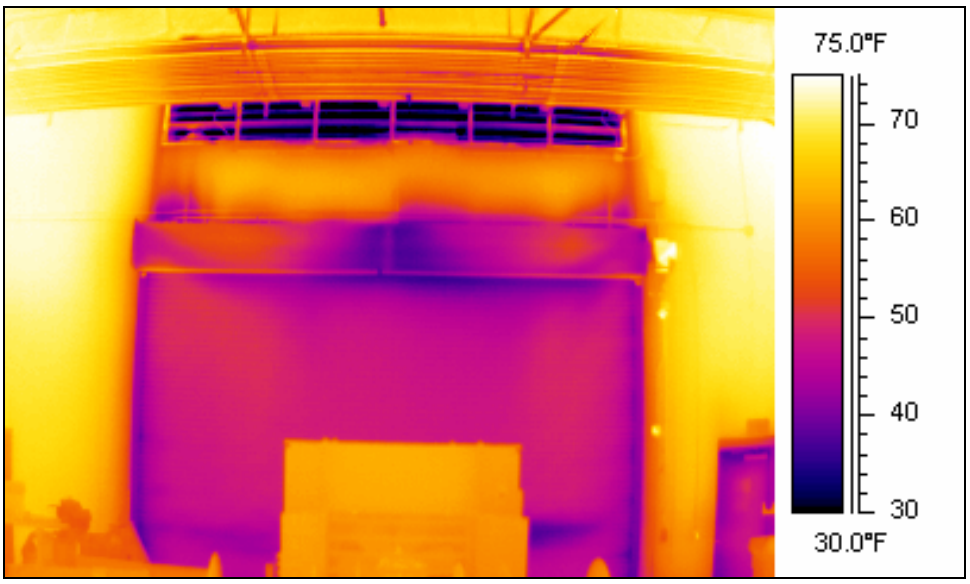


Figure 44. Visual and thermal imagery of the garage door from inside the mechanical room, shown in View Number 18 (App. D) on 21 March 2006.

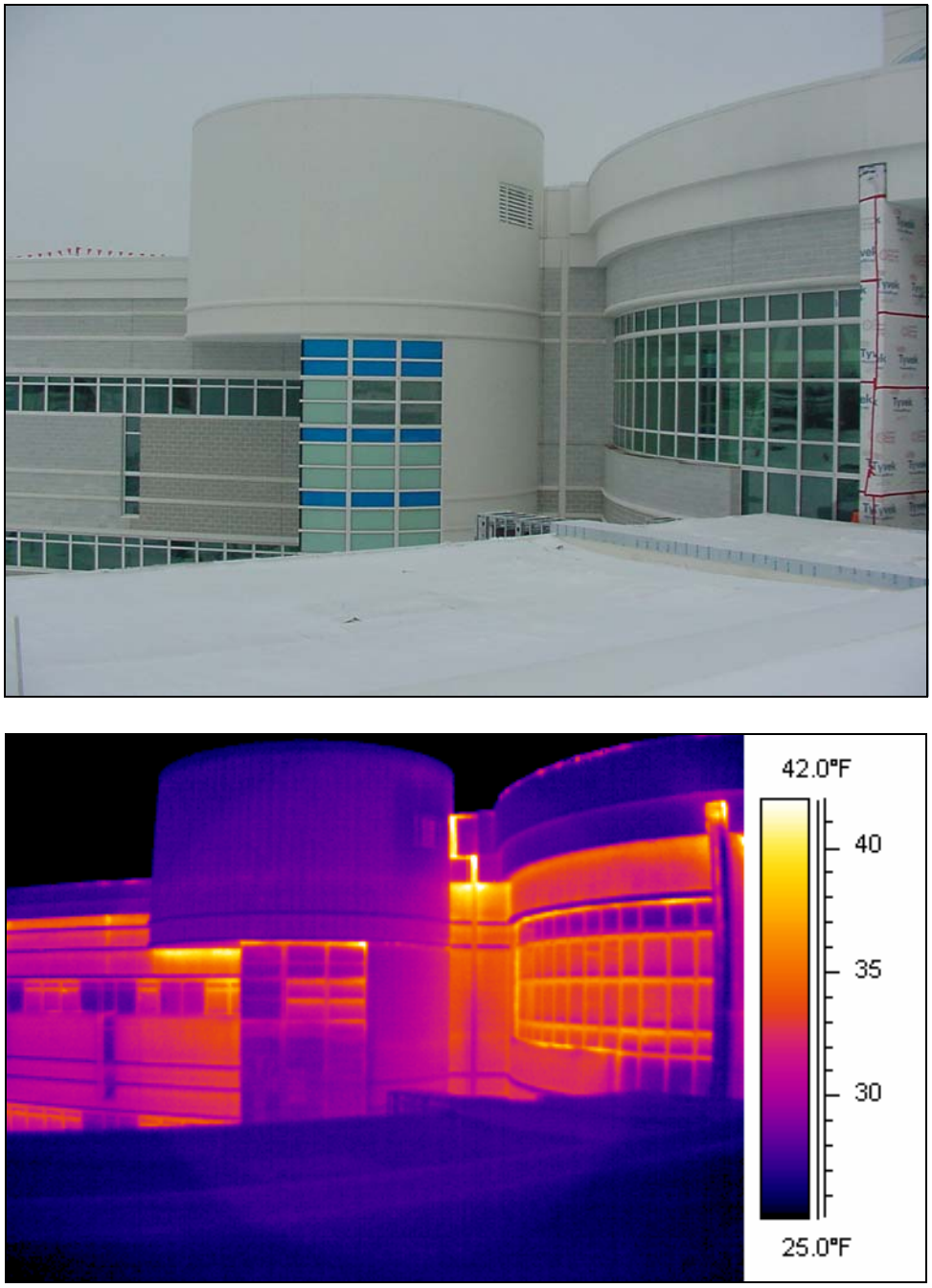
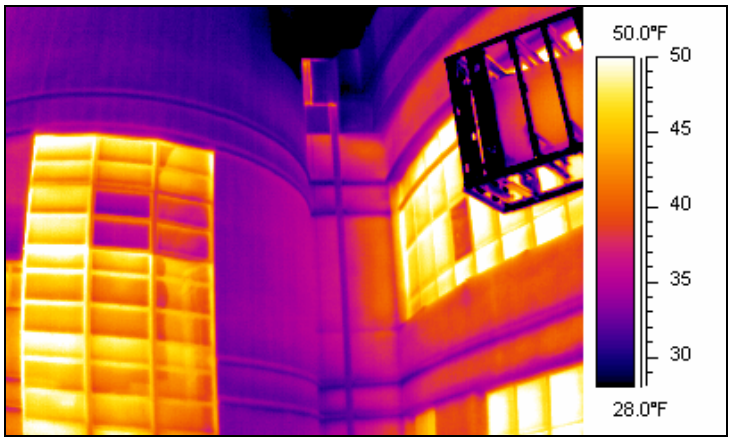


Figure 45. Visual and thermal imagery showing the seismic joint to the left of the main entrance to the New Bassett Hospital on 21 March 2006. A plan view of this seismic joint shows its circular path around the central core of the hospital.



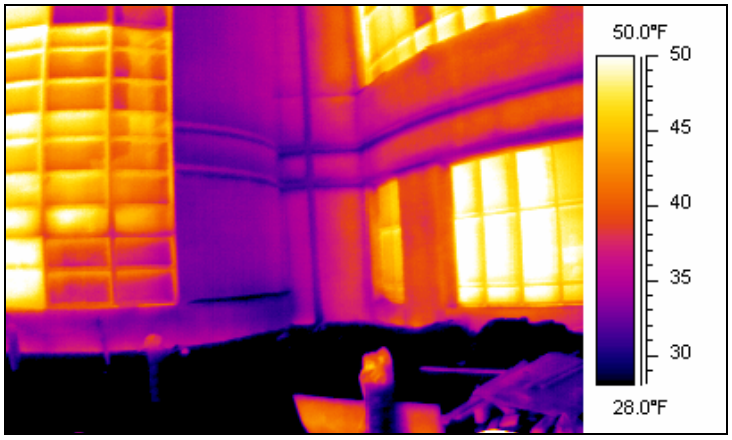
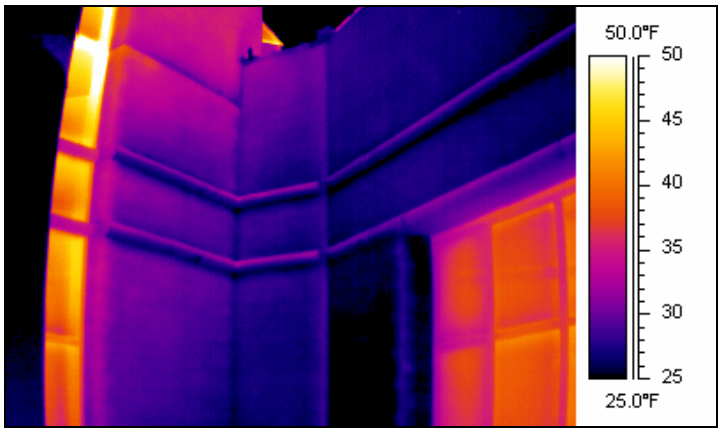


Figure 46. Close-up visual and thermal imagery showing the seismic joint to the left of the main entrance to the New Bassett Hospital on 21 March 2006.



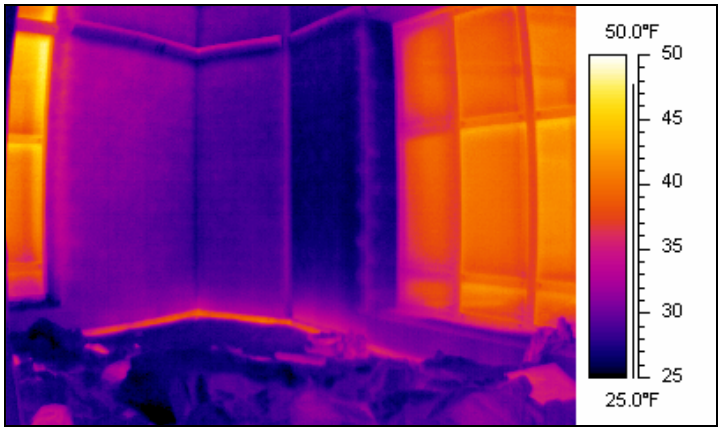


Figure 47. Close-up visual and thermal imagery showing the seismic joint to the right of the main entrance to the New Bassett Hospital on 20 March 2006.

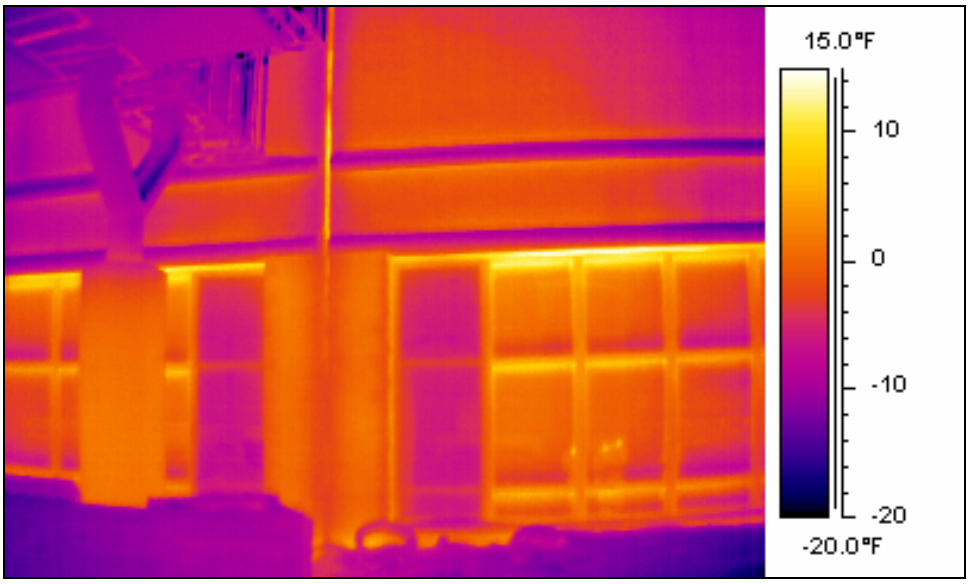


Figure 48. Close-up visual and thermal imagery showing the 15-Line seismic joint near View Number 6 in Figure 5 on 18 March 2006. The joint was open and was still under construction.

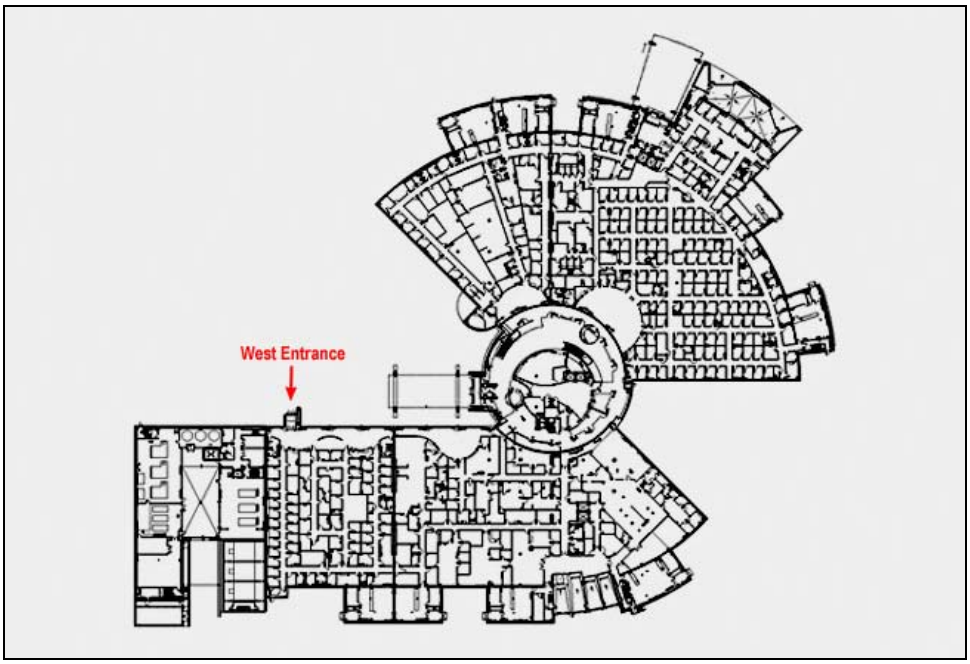


Figure 49. Location of the West Entrance at the New Bassett Hospital. The north side of the building is at the right side of the figure.

Figure 50. Personnel lift used to take visual and thermal imagery of the West Entrance roof.

Figure 51. Unfinished flashing around the roof over the West Entrance of the New Bassett Hospital. The north side of the building is at the left side of the photo.

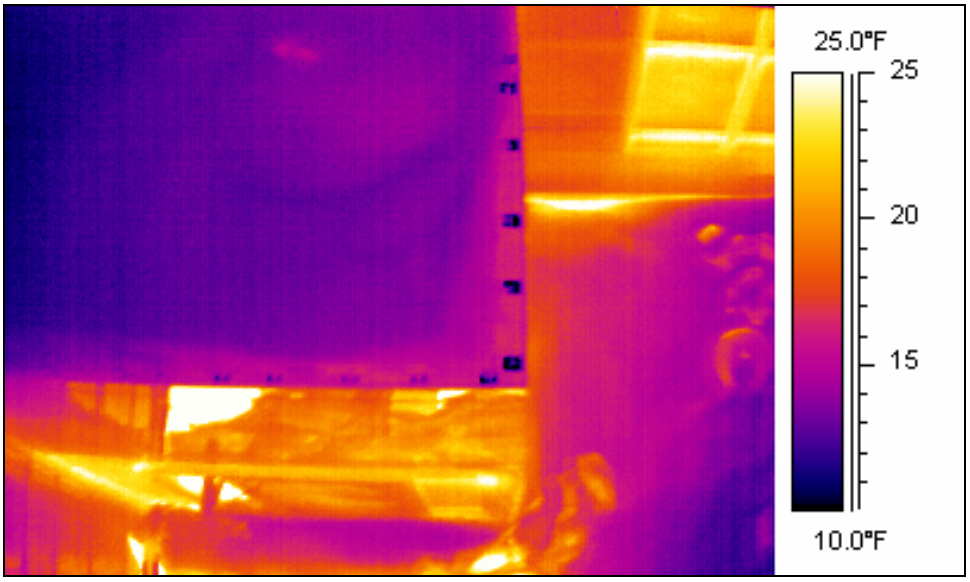


Figure 52. Thermal image of the southwest corner of the roof over the West Entrance.

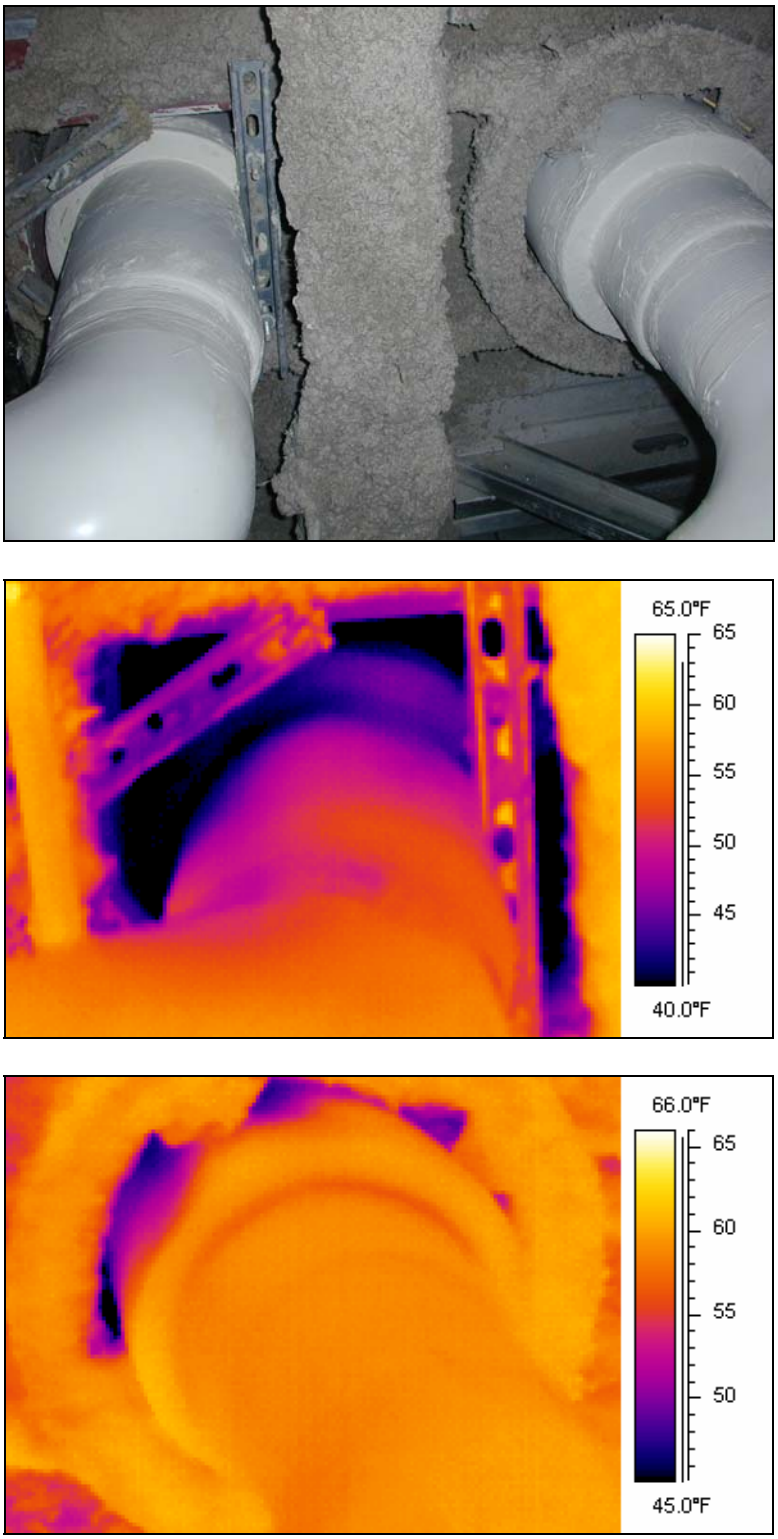


Figure 53. Visual and thermal imagery of the roof drains inside the West Entrance of the New Bassett Hospital. The north roof drain is shown in the top IR image, and the south roof drain is shown in the bottom IR image. This imagery was obtained in the space between the ceiling and the roof.

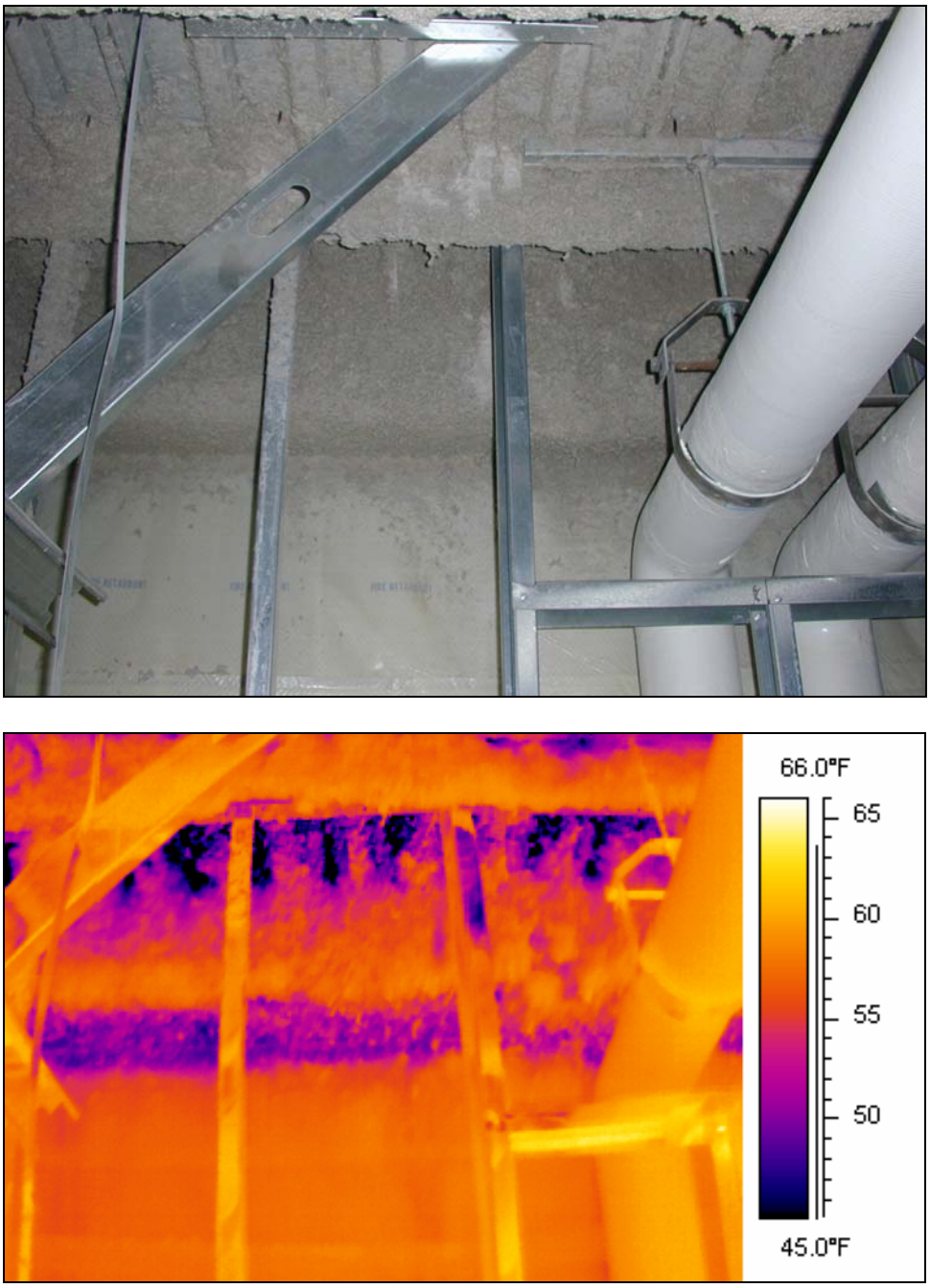


Figure 54. Visual and thermal imagery showing the north wall of the West Entrance in the space between the ceiling and the roof.

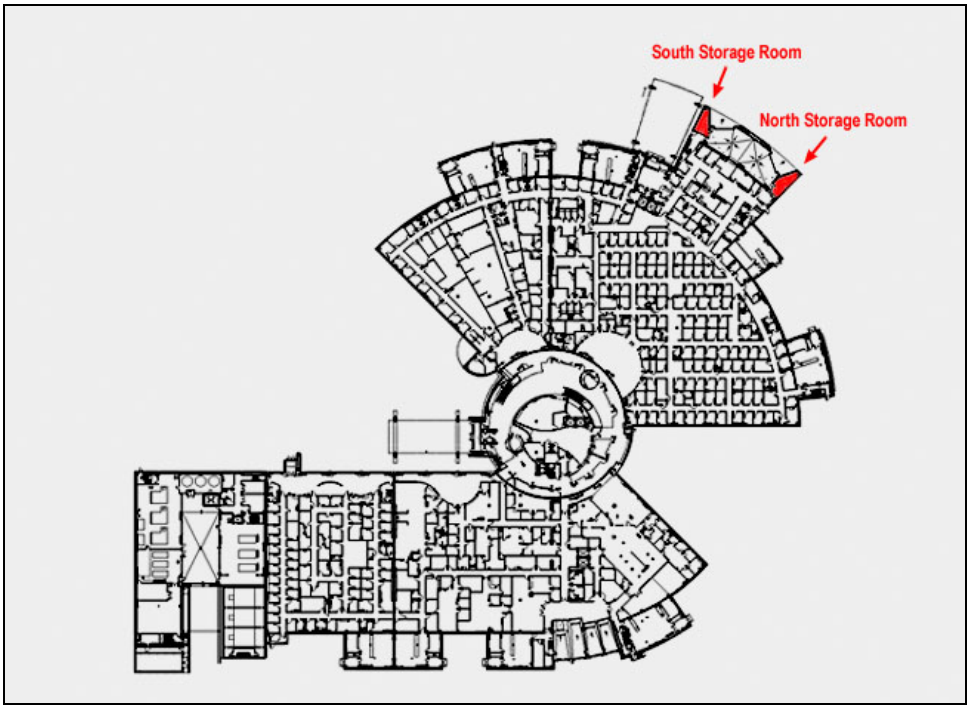


Figure 55. Location of the ambulance storage rooms at the New Bassett Hospital. The north side of the building is at the right side of the figure.

Figure 56. South ambulance storage room, located behind the short wall in the center of this photo. Both ambulance storage rooms have three exterior walls at their small ends.

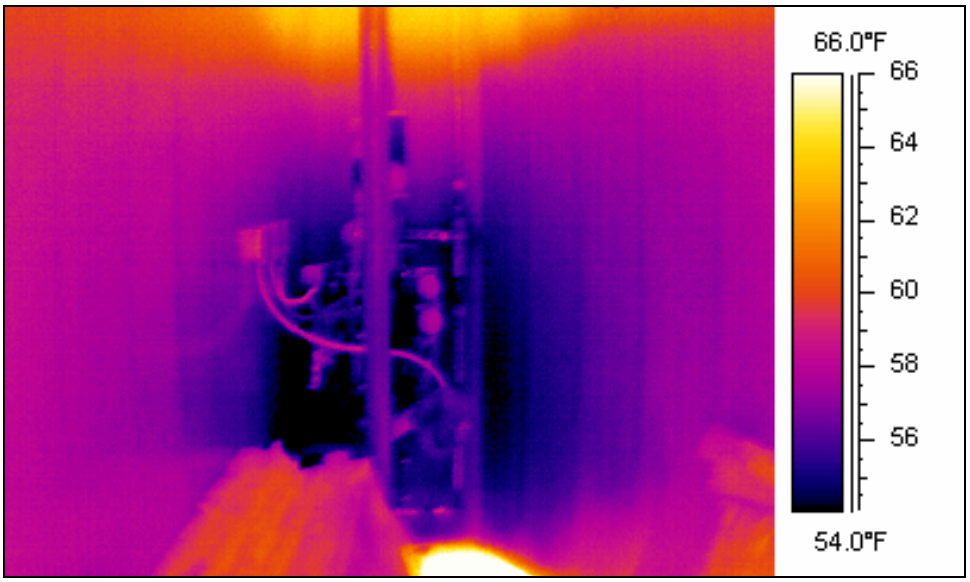


Figure 57. Sprinkler system in the south ambulance storage room, located at the small end of the room surrounded by three exterior walls. The thermal image shows the sprinkler system located in the coldest spot in the room.

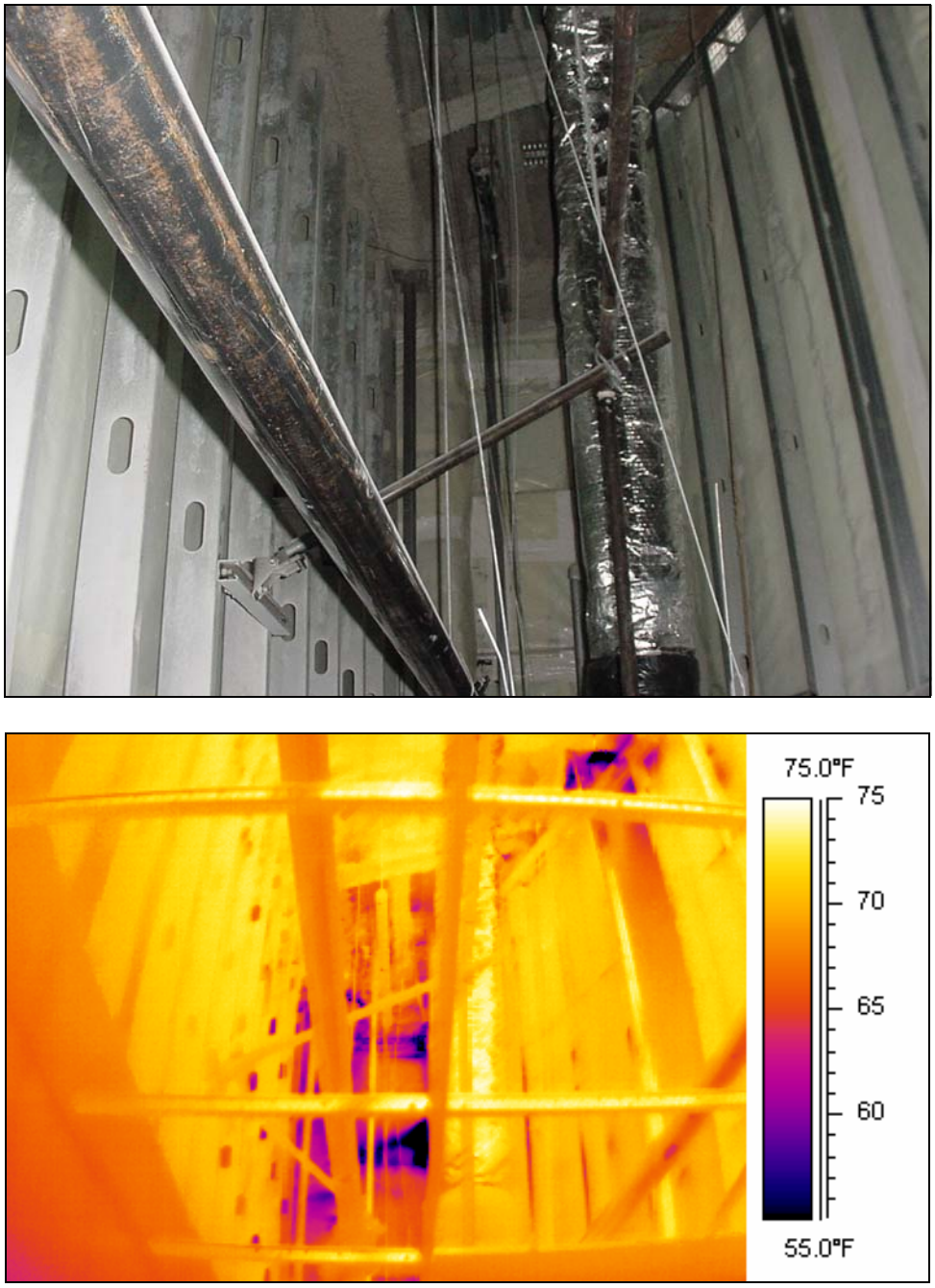


Figure 58. View above the ceiling tiles showing visual and thermal imagery of the short wall at the small end of the south ambulance storage room. IR image was taken below the ceiling grid.

Figure 59. Drain pipe (the white elbow fitting in the center of the photo) that passes through the exterior wall of the ambulance storage room. It’s not sealed, and there is considerable air leakage around it.

Figure 60. Drain located outside of the exterior wall of the south ambulance storage room.

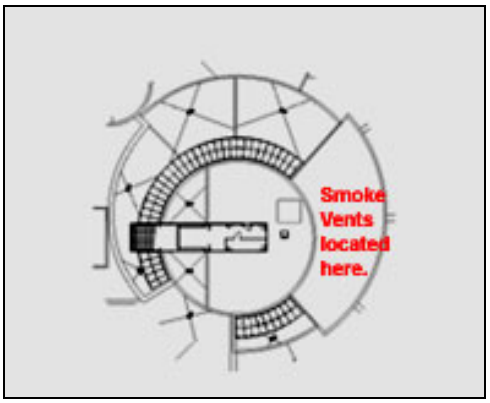


Figure 61. Location of smoke evacuation fans at the New Bassett Hospital. The north side of the building is at the right side of the figure.

Figure 62. Smoke evacuation stacks at the New Bassett Hospital on 19 March 2006. This imagery was taken from the third-floor roof level looking south.

Figure 63. Smoke evacuation louver on the high ceiling inside the New Bassett Hospital.

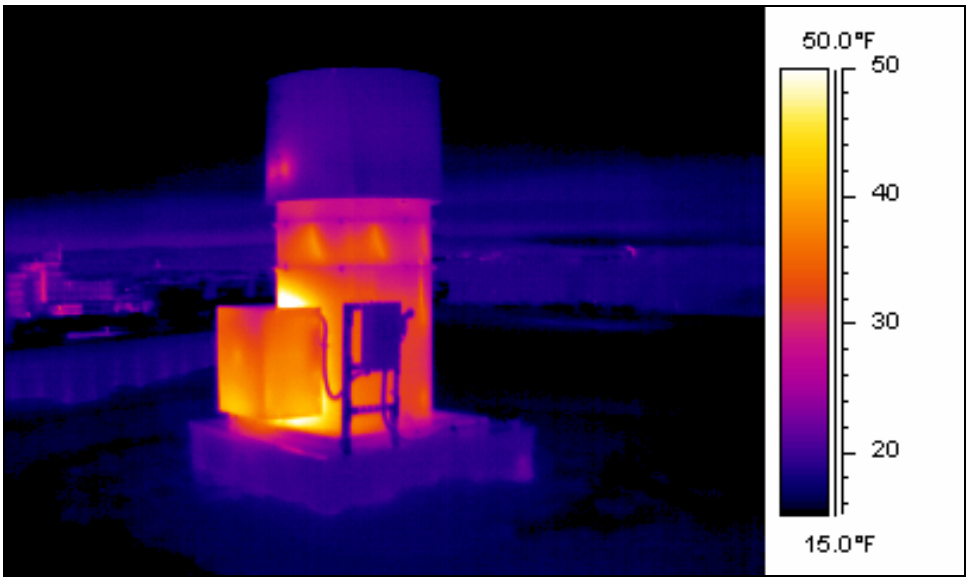


Figure 64. West smoke-evacuation fan showing visual and thermal imagery on 19 March 2006. These smoke evacuation fans are major heat loss locations.

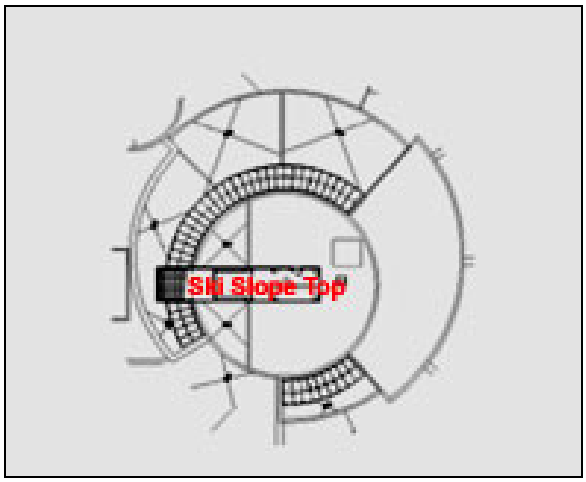


Figure 65. Location of the ski slope just above the fourth-floor level at the New Bassett Hospital. The north side of the building is at the right side of the figure.

Figure 66. Ski slope at the New Bassett Hospital on 19 March 2006. This imagery was taken from the first-floor roof level looking northwest.

Figure 67. Ski slope at the New Bassett Hospital on 19 March 2006. This imagery was taken looking east from the roof just below the base of the sloped glazing.

Figure 68. View taken from the upper level inside the ski slope looking south. The ski slope functions as an air intake plenum and is an architectural feature of the facility.

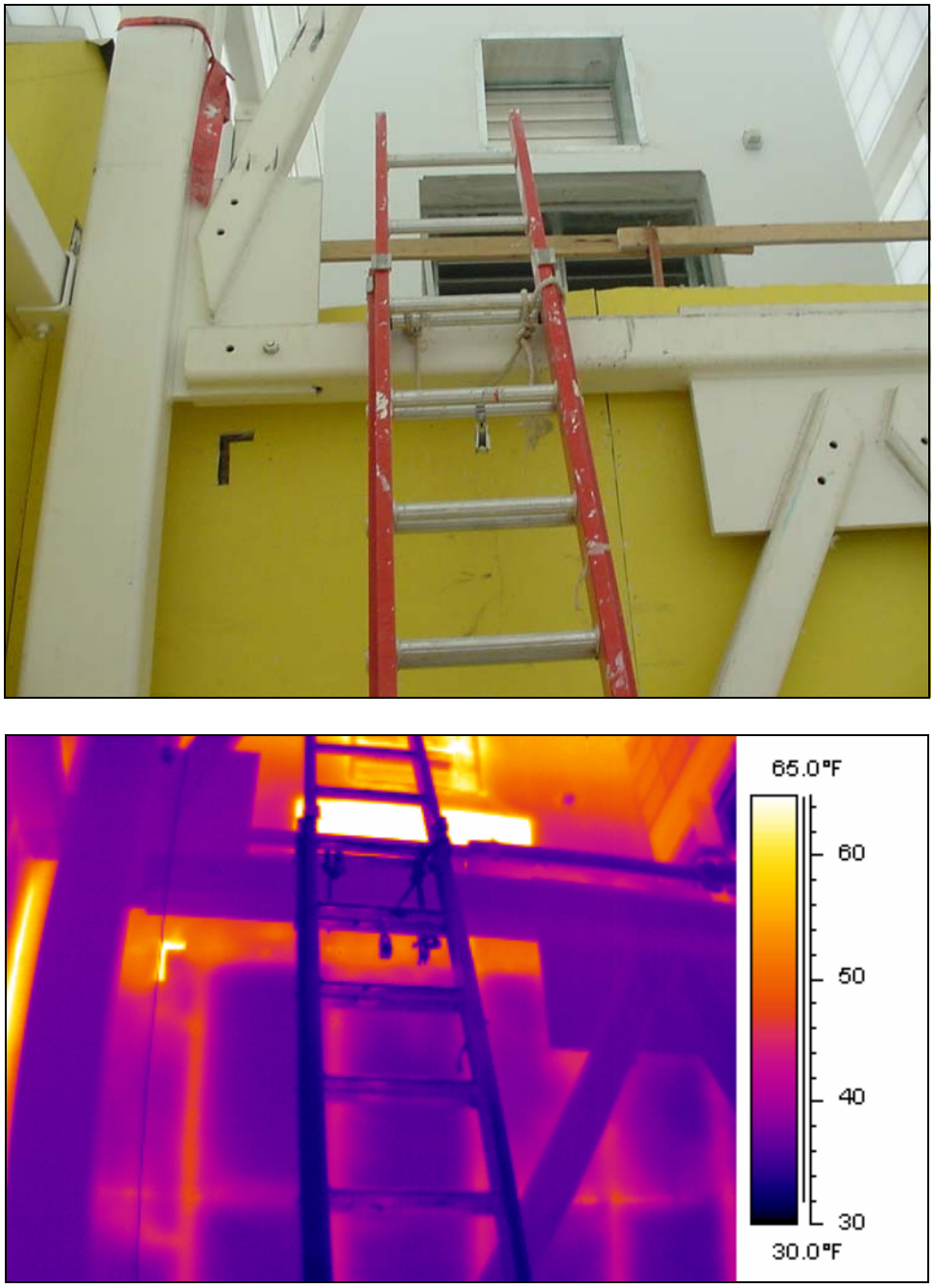


Figure 69. View inside the ski slope showing visual and thermal imagery on 19 March 2006. The view was taken from the lower level looking up towards the air intake louver on the upper level. The louver is the warmest surface in this thermal image at about 70°F.

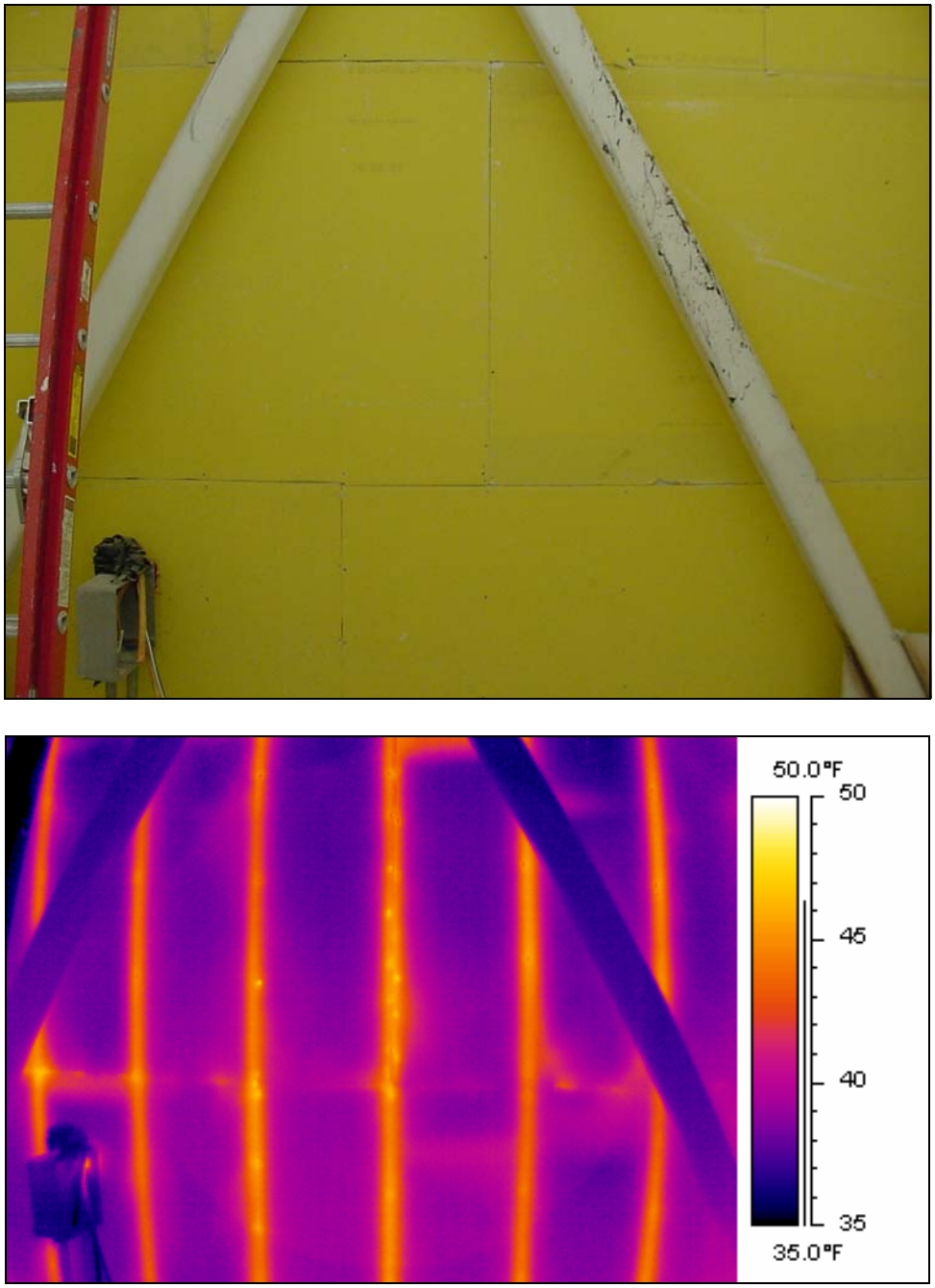


Figure 70. View inside the ski slope showing visual and thermal imagery on 19 March 2006. The view is from the lower level looking at the north wall just below the upper level. The area behind this wall is just above the conference center ceiling.

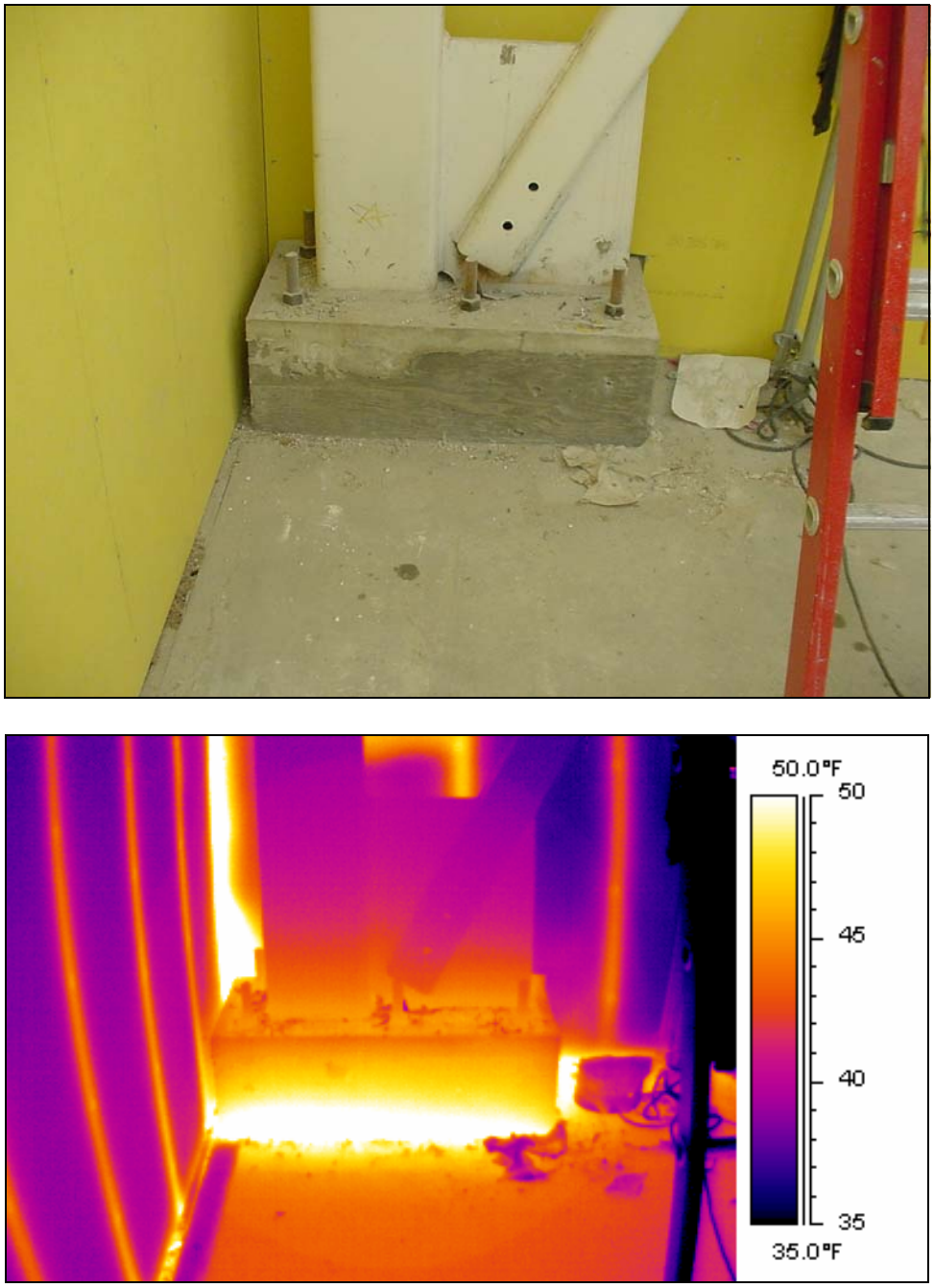


Figure 71. View inside the ski slope showing visual and thermal imagery on 19 March 2006. The view is from the lower level looking at the northwest corner (the intersection of the west and north walls with the lower level floor). The bright areas are all warmer than 50°F, with the vertical joint the warmest surface in this thermal image at about 65°F.

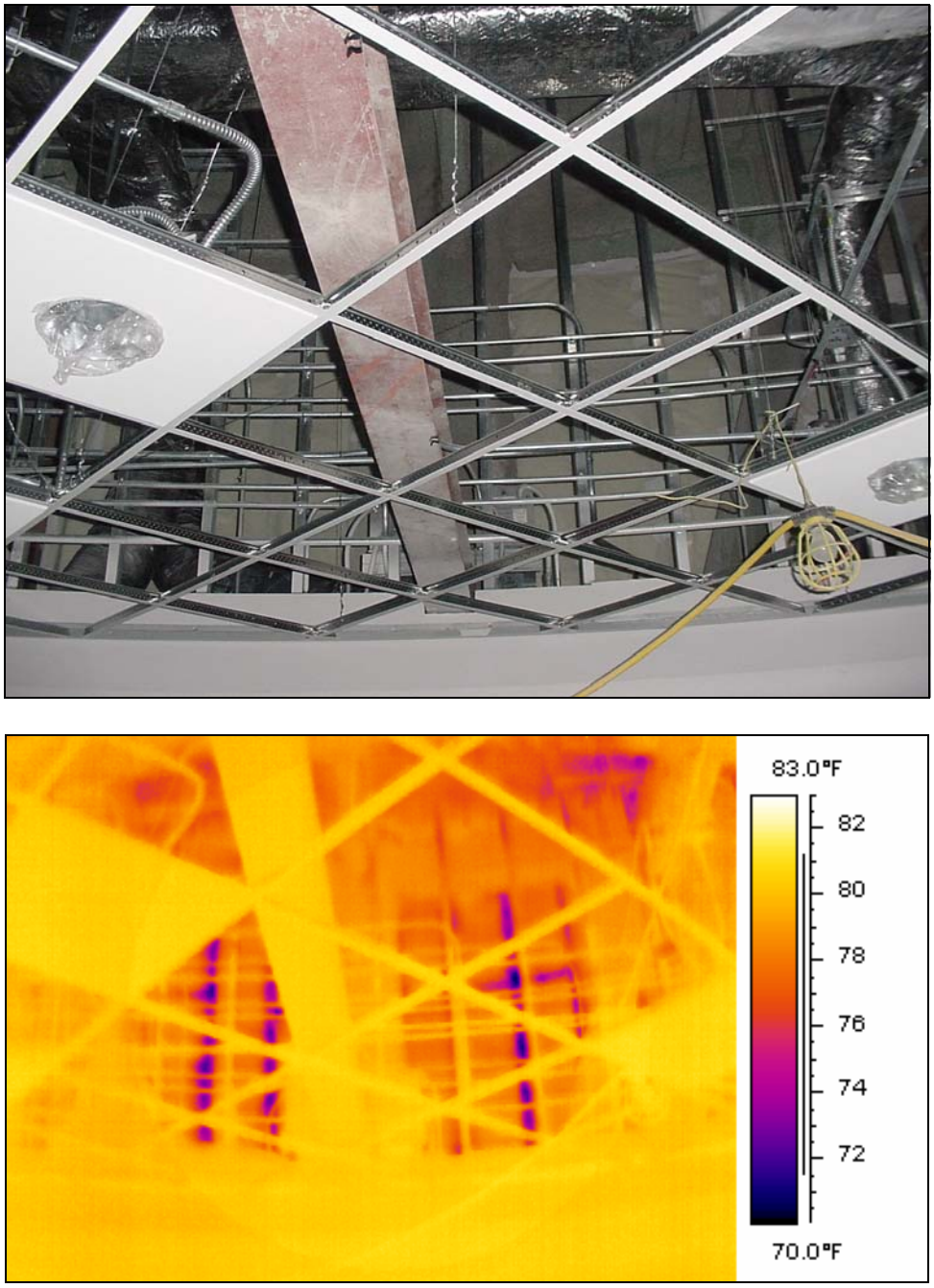


Figure 72. South wall of the area above the ceiling of the conference room on 19 March 2006. The view is from inside the conference center looking up towards the back side of the wall shown in Figure 70. The steel studs are the coldest surfaces in this thermal image, at about 70°F. This wall should be better insulated.

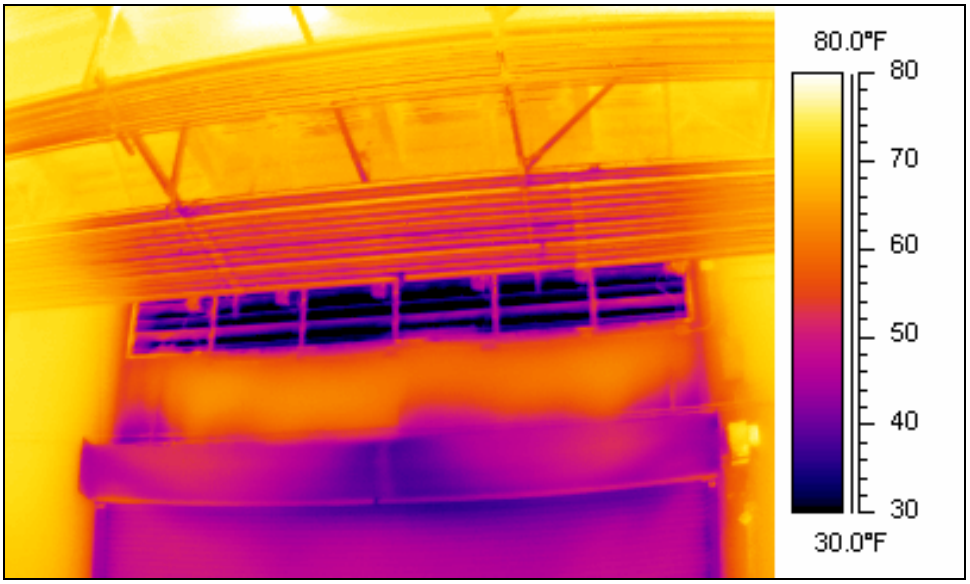
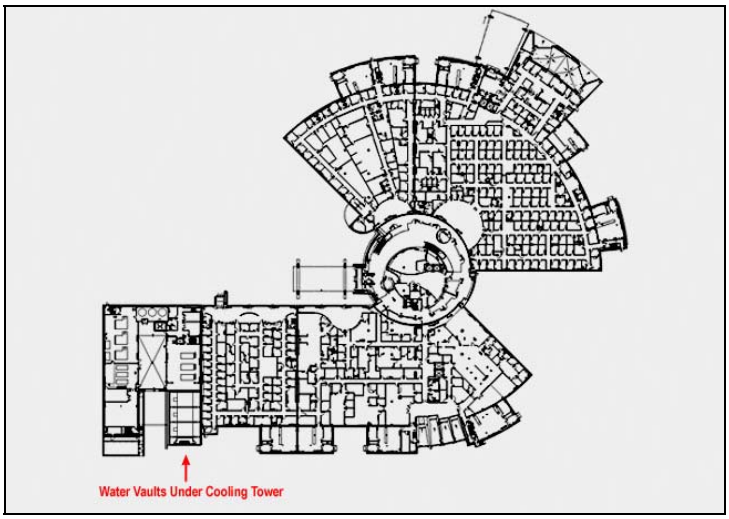


Figure 73. Air intake louver in Room 135-11 over the garage door shown in Figure 43. A concern is that the sprinkler heads and pipes located near this louver could freeze when it opens during periods of extremely cold weather.



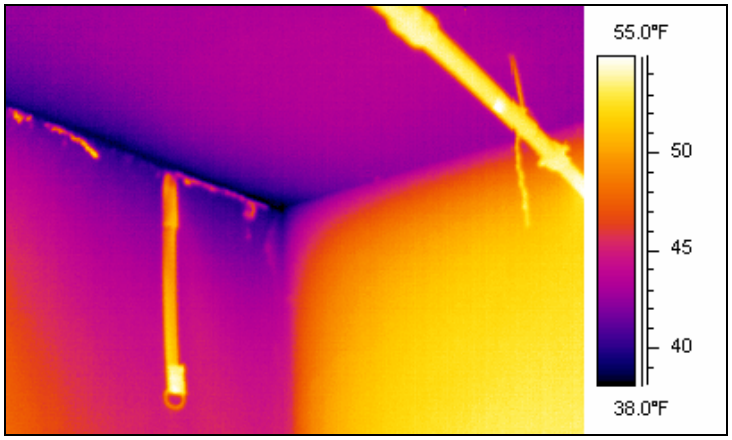


Figure 74. Exterior wall and ceiling in the north tunnel of the east water vault under the cooling tower. The cooler exterior wall is behind the rigging strap. The warmer wall is next to the stairway.

Appendices

Appendix A: Attendees at 17 March 2006 Meeting

U.S. Army Corps of Engineers
Bassett Resident Office (BRO)

Meeting : CRREL Site Work Contract Title: Bassett Replacement Hospital

Date 17 March 2006 Project Number: FTW – 171B

Name	Title	Company	(Area) Telephone No.
Jim Buska	Research Civil Engineer	ERDC - CRREL	603 - 646 - 4588
Kerry Claffey	Research Scientist	CRREL	603- 646- 4634
Mikk Sepp	Architect	HKS/WS.	353-5834
ROGER GREEN	COE - PM	COE	907-353-5823
FRANCISCO GONZALEZ	HKS/WS	HKS/WS	DIALED IN
Dale Nelson	Cof E	Cof E	907-353-7550
DAN GERDES	TECH ENGR	HFPO-AK	907-353-5831
MAJ MICHAEL WILLIAMS	CHIEF	HFPO-AK	907-353-5857
BRENT WILLSON	ARCHITECT HKS/WS	HKS/WS	907-322-3151.
FRANCISO GONZALEZ.	ARCHITECT HKS/WS	HKS/WS	907 5599.
Phillips Norton	DAR	COE	907 353-5841
Ray Drennon	QAR	COE	907-322-4149
JERRY HOLLAND	QAR	COE	907-353-5843
Richard STORE	QC Mechac-AK FAC.	Fac.	907-353-5229

RSB
File h:\qar\gerry sign-in sheet.doc
Created 11-Sep-98

Appendix B: List of Areas of Interest

Bassett Replacement Hospital (FTW-171B) 17 March, 2006

List for CRREL infra-red imaging:

1. Seismic joint @ 19/20 line – both vertical and horizontal (across roof joint).

2. East and West Arctic entries:
a) East Arctic Entry: vertical – where it joins the building @ 18.4/Q lines.
b) West Arctic Entry: vertical – where it joins the building @ K line (both sides), and also the roof, particularly where it abuts the glazed wing wall.

3. Seismic joints – (remember Z5/ZC joint @ level 3 roof).

4. Emergency: rooms 101-01 (X16) and 101-02 (X13) - adjacent to Ambulance garage – roof and head of walls.

5. Wall sections:
a) 10 line east – from ZA line to ZE line, level 2.
b) X16 line – ZK to ZJ.
c) Q line – 16.5 to 18.4 lines, 13.5 to 12 lines.
d) ZC line @ level 3 roof - Z3 to Z5.

6. Ski Slope: ZA line wall @ level 3.5 to 4 - also level 4 Mech, South wall and lid.

7. Smoke exhaust fans on the roof, level 4.5 Green.

8. Building corners – possible missing insulation. (per Ken Hoganson)

9. Service Bay walls. (per Richard Stone)

10. Thermal breaks @ parapets – Mikk will advise. (per Francisco Gonzales)

Appendix C: Attendees at 21 March 2006 Out-Brief

U.S. Army Corps of Engineers
Bassett Resident Office (BRO)

Meeting : CRREL Site Work Contract Title: Bassett Replacement Hospital

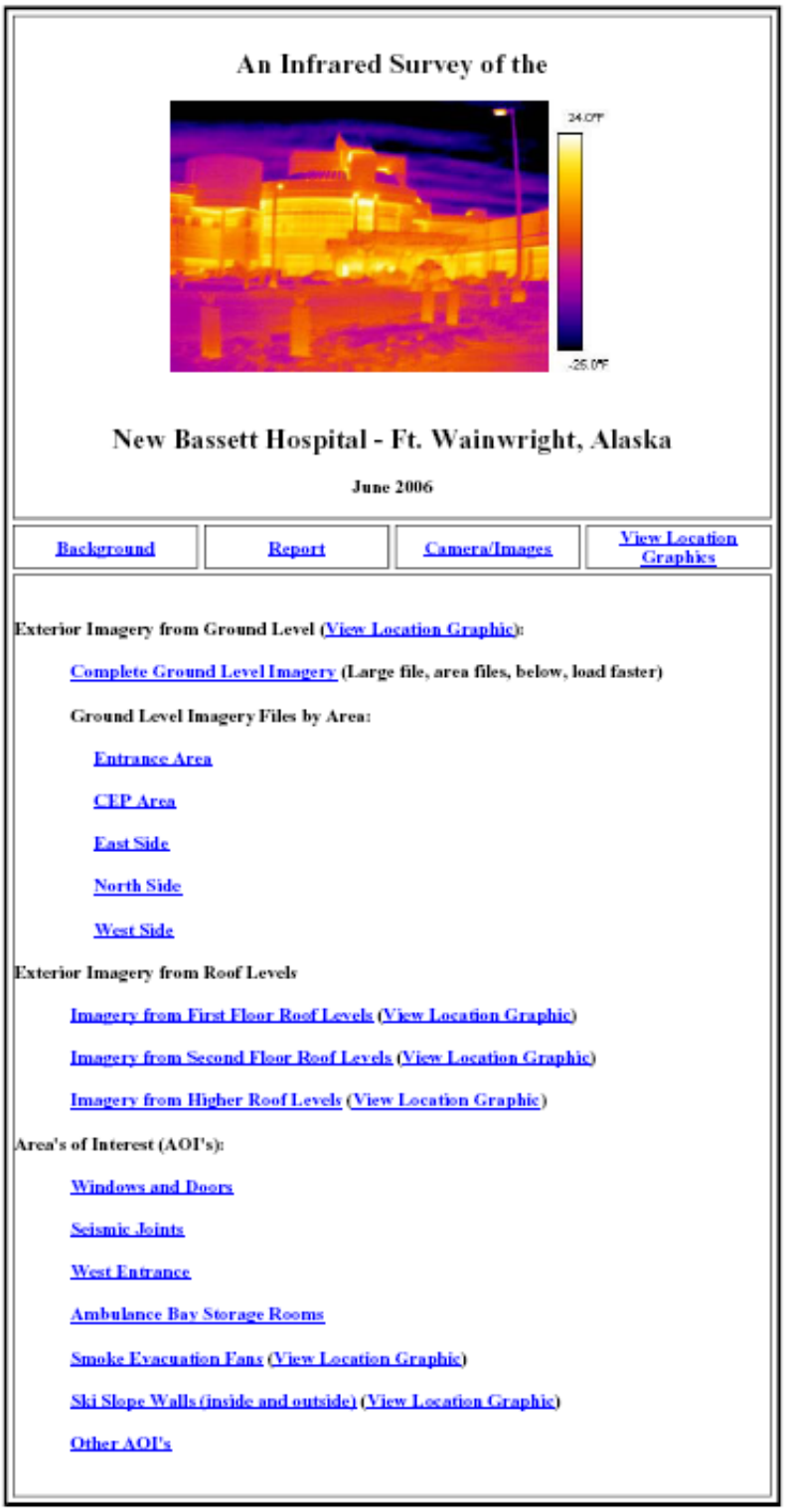
Date 21 March 2006 Project Number: FTW – 171B

Name	Title	Company	(Area) Telephone No.
Mikk Sepp	Architect	HKS/WS	353-5834
DAN GERDES	TECH ENGR	HFPO-AK	353-5831
JERRY HOLLAND	QAR	COE	353-5843
Rolf Ness	Acting RE	COE	353 5835
Harry Kappel	MEDDAC-FM	MEDDAC	353-5673
MAJ MICHAEL WILLIAMS	CHIEF, HFPO-AK	HFPO-AK	353-5857
Dale Nelson	Chief Construction	C of E	353-7550
ROGER GREEN	PM	COE	353-5823
Kevin Hodgson	Q.C. MANAGER DPC/JV	DPC/JV	356-5304
Kerry Claflin	IR Camera	CRREL	603-646-4634
Jim Buska	Res. Civ. Engr	CRREL	603-646-4588
Ken Wheatley	Mech Engineer	Goetting & Assoc	210 530-7000
Francisco Gonzalez	Project Principal [redacted]	HKS/WS.	214-969-5599

RSB
File h:\qar\gerry sign-in sheet.doc
Created 11-Sep-98

Appendix D: CD of Imagery

The image below is the Index on the CD of Imagery.



An Infrared Survey of the

New Bassett Hospital - Ft. Wainwright, Alaska

June 2006

Background | Report | Camera/Images | View Location Graphics

Exterior Imagery from Ground Level (View Location Graphic):

Complete Ground Level Imagery (Large file, area files, below, load faster)

Ground Level Imagery Files by Area:

Entrance Area

CEP Area

East Side

North Side

West Side

Exterior Imagery from Roof Levels

Imagery from First Floor Roof Levels (View Location Graphic)

Imagery from Second Floor Roof Levels (View Location Graphic)

Imagery from Higher Roof Levels (View Location Graphic)

Area's of Interest (AOI's):

Windows and Doors

Seismic Joints

West Entrance

Ambulance Bay Storage Rooms

Smoke Evacuation Fans (View Location Graphic)

Ski Slope Walls (inside and outside) (View Location Graphic)

Other AOI's